The Journal of
NERVOUS and MENTAL DISEASE

VOL. 131, NO. 3
September, 1960
SERIAL NO. 934

ELECTROPHYSIOLOGICAL CORRELATES OF DIFFERENTIAL APPROACH-AVOIDANCE CONDITIONING IN CATS[1]

E. ROY JOHN, PH.D.[2] AND KEITH F. KILLAM, PH.D.[3]

INTRODUCTION

In previous work (3), we have described changes in electrical activity recorded from various areas of the central nervous system of cats during the process of familiarization and subsequent acquisition of a conditioned avoidance response. The conditioning stimulus employed was a light source flickering at 10 c.p.s., which we have called a "tracer conditioning stimulus" (TCS). The most striking findings were changes in the distribution and form of the potentials evoked by the presentation of the TCS. The evoked potentials having the frequency characteristics of the TCS were termed "labelled responses" (LR). The purpose of the research reported in the present paper was to investigate the effects of other kinds of conditioning on the evoked labelled responses. The effects of simple approach conditioning, differential approach conditioning and differential approach-avoidance conditioning will be described and contrasted with those observed during familiarization and simple avoidance conditioning.

[1] These investigations were supported in part by grants from the Ford Foundation to the Dept. of Anatomy, by grant B611 from the National Institutes of Health, by grant G-3354 from the National Science Foundation and by a Senior Research Fellowship to K.F.K. from the United States Public Health Service.

[2] Departments of Physiology, Pharmacology and Anatomy, University of California Medical Center at Los Angeles. Present address: Department of Psychology, University of Rochester, Rochester, New York.

[3] Present address: Department of Pharmacology, Stanford University School of Medicine, Palo Alto, California.

METHOD

In four adult cats, 7 or 8 bipolar electrodes were implanted using stereotaxic techniques into various subcortical structures and 2 or 3 bipolar electrodes were similarly placed on various cortical areas. The techniques of chronic implantation have been described previously (3). Among the structures from which data were obtained were visual (VIS) and auditory (AUD) cortex, medial (MSS) and posterior suprasylvian gyrus (PSS), lateral geniculate (LG) nucleus, centralis lateralis (CL), lateral (AL) and basal (ABM) amygdala, dorsal and ventral hippocampus (DH) and (VH), dentate (DENT), reticular formation (RF), and fornix (FX). Electrode placements were confirmed by histological examination at the end of the experiments.

Behavioral procedures were carried out in a sound-resistant, shielded two-compartment hurdle box, one wall of which contained a one-way vision mirror. The lever used in approach training was mounted over a lucite dish into which milk could be delivered in measured aliquots. The floor of the apparatus consisted of a grid of brass rods through which electrical shocks could be delivered to the feet of the animals. A fluorescent tube mounted in the rear wall of the apparatus provided the visual stimulus and could be made to flicker at any frequency. The same tube provided steady light at the same intensity between periods of flicker. The light intensity was moderate but sufficient to illuminate the entire interior of the box. The tube was shielded and no audible sound accompanied the on-off switching.

Following a 2-week recovery period after surgery, the animals were placed in the test chamber for daily conditioning sessions. Electrical recordings were made from the implanted electrodes using a Grass Model III B electroencephalograph during all sessions and procedures described below. Periodic checks were made to assure that the electrical responses recorded were not due to artifacts introduced by the equipment. The fluorescent tube was covered with cardboard to block the light, testing for possible electromagnetic radiations into the chamber. The photocell monitoring the flashing light was removed to control for possible radiations when it was energized. The output leads from the animals were moved to different terminals on the EEG input terminal box to control for possible cross-talk. Records were taken with the apparatus in the normal recording hook-up except that a 10,000 ohm dummy load was substituted for the animal. Finally, the experimenter would cover the animal's eyes with his hands. Under all the conditions described no evidence of artifacts attributable to the apparatus used could be discerned.

EXPERIMENTAL PROCEDURES

FAMILIARIZATION

All of the cats were subjected to a familiarization procedure. During this phase, twenty 15-second periods of 10 c.p.s. flickering light were presented for ten to twenty days. The time interval between presentations of the flickering light was randomly varied from 15 to 75 seconds so that on the average there occurred one presentation per minute over a total time of 20 minutes. The cats were presented with a small number of periods of light flashing at 6 c.p.s. interspersed with 10 c.p.s. to ascertain whether the diminution of the electrical response to the latter was differential. During these procedures no other changes in the environment were imposed upon the animals.

APPROACH TRAINING

After the familiarization procedure, a conditioned lever pressing habit for a milk reinforcement was established in a number of steps. During this period, the animals were maintained on a diet of dry rat chow and received fluids only in the experimental chamber.

Operant conditioning. The cats were conditioned to press the lever mounted at the end of the apparatus to obtain a 2.0 c.c. aliquot of milk delivered to the lucite bowl under the lever. Lever presses were *invariably* reinforced during this period. Presentation of 15 second periods of 10 c.p.s. flicker occurred at random intervals during this procedure but no attempt was made to relate the presence of flicker during the lever pressing to the delivery of milk. The cats rapidly established a steady rate of lever pressing ranging from two to four responses per minute.

STIMULUS-CONTROLLED OPERANT BEHAVIOR

Once a steady rate of response had been established the training procedure was modified to bring the lever pressing behavior under stimulus control. Reinforcement was delivered only when lever pressing occurred during a flicker period. The initial response of the cats to this change in procedure was a display of a five- to six-fold increase in the rate of lever pressing. In two of the cats, to accelerate establishment of the stimulus-cued response, the procedure was slightly modified so that the apparatus was totally dark except during flicker periods. It was expected that this intensification of the contrast between TCS and non-TCS periods would facilitate extinction of the lever pressing response during non-TCS periods. When stimulus control had been established under these conditions, the procedure was modified once more so that the fluorescent light provided steady illumination between trials, and stimulus control was re-established under the new conditions. The other

two cats were trained exactly as described above except that the condition of darkness during inter-trial intervals was not employed. Approximately 75 trials a day were presented, randomly spaced during a one-hour training session.

DIFFERENTIAL APPROACH TRAINING

Once the lever pressing response was under control of the 10 c.p.s. flicker, training was instituted to establish a discrimination between 10 c.p.s. and 6 c.p.s. flickering light. Lever pressing was reinforced if it occurred during 10 c.p.s. flicker (S^D) but not during 6 c.p.s. flicker (S^Δ). Fifty to seventy-five presentations of each stimulus, randomly intermixed and randomly spaced, occurred during daily sessions lasting 60 to 90 minutes.

DIFFERENTIAL APPROACH-AVOIDANCE TRAINING

When the discrimination between the two flicker frequencies was established for lever-pressing, a further modification was introduced. Lever pressing during 10 c.p.s. flicker continued to be reinforced with milk. However, failure of the animal to leap the hurdle within fifteen seconds after the onset of 6 c.p.s. flicker was reinforced with intermittent shocks of 0.2 to 0.4 mA. to the feet of the animal once every 5 seconds until it crossed the hurdle (escape), at which time shock was terminated and the flickering light replaced by steady light. If crossing of the hurdle occurred *within* 15 seconds after the onset of the 6 c.p.s. flicker (avoidance), the flickering light was replaced by steady light and no shock was delivered. The time interval between the onset of the 6 c.p.s. flicker and performance of the CAR was recorded as the "response latency." This training procedure was continued daily until crossings occurred in 15 seconds or less in response to all 6 c.p.s. presentations on a single day, that is, until no shock was delivered to the animal throughout an entire day's training session (100% CAR).

To minimize the possibility that experimental neuroses would ensue from these procedures, a number of precautions were taken. As CAR training to 6 c.p.s. flicker was instituted, each session began with a series of 10 c.p.s. flicker presentations. Lever pressing to the latter frequency was reinforced with milk. After 50 trials using 10 c.p.s. flicker, the lever was removed from the apparatus and the CAR training procedure was followed. During this period only 6 c.p.s. flicker was presented.

As performance of the CAR to 6 c.p.s. flicker began to be displayed, a small number of 6 c.p.s. flicker presentations, not reinforced with shock, were interspersed during the series of 10 c.p.s. flicker trials while the lever was in the apparatus. Similarly, a small number of 10 c.p.s. flicker presentations, not reinforced, were included in the 6 c.p.s series with the lever removed from the apparatus. The amount of such mixing of the two frequencies within the trial series was gradually increased as CAR performance to 6 c.p.s. improved and as other evidence of discrimination between the two frequencies was observed.

However, the basic paradigm of a predominantly approach period followed by a predominantly CAR period was retained throughout the procedure. These methods were not considered ideal for coping with the problem of establishing a perfect discrimination to a balanced and randomly mixed approach-avoidance sequence without the appearance of neurotic behavior. It is hoped that this shortcoming may be remedied in future work by the use of a somewhat altered conditioning method.

An advantage of the procedure as used was that data were obtained at each stage of performance of the CAR with respect to the electrical and behavioral responses to both the 10 c.p.s. flicker (S^D) and the 6 c.p.s. flicker (S^Δ). The portion of the daily session which was predominantly approach response

conditioning (more 10 c.p.s. flicker presented than 6 c.p.s. flicker) was termed the APPROACH PHASE; and the portion predominantly avoidance conditioning, CAR PHASE.

ANALYSIS OF DATA

At each stage of the various procedures described above, four to twelve records were selected which appeared to be prototypic of the electrical responses for a given animal at that stage of conditioning. From these records, the amount of labelled response was scored for each electrode placement using the following procedure:

If no potentials at the frequency of the TCS were observed in the records during a particular trial, the record was scored as 0. If some indication of labelled potentials was present but neither marked nor regular in character, the record was scored as 1. If labelled responses were marked but intermittent, it was scored 2. If the labelled responses were marked and regular, the score was 3. The scores for common electrode placements in all animals at each stage were averaged.

It must be kept in mind that the scoring procedure used provided a markedly nonlinear scale where small, scored differences represent large changes in the observed responses.

RESULTS

FAMILIARIZATION

As had been observed previously (3), during the familiarization procedure the labelled responses diminished appreciably in the recordings from most of the structures studied. A detailed description of these changes will be reported elsewhere for all of the animals studied (7). In some animals a limited number of presentations of 6 c.p.s. flicker were included during familiarization to 10 c.p.s. flicker. In Table 1, it can be seen that the diminution of the labelled responses is specific to the frequency with which the animal was familiarized. This is most clear in electrode placements in other than the classical afferent pathways.

APPROACH TRAINING

First presentation of milk. At this stage the animals have neither perfected the motor response of pressing the lever to obtain milk nor associated the motor response with the presentation of flickering light. At this time the generalized effect of reinforcement of a behavior may be assessed in terms of responsiveness of the central nervous system. The animals appeared tense and alert. Slight increases in the amounts of labelled responses were observed in the visual cortex (VIS) and lateral geniculate (LG). Marked increases

TABLE 1

*Differential Effects of Familiarization: Average Labelled Response in Various Structures Before and After Familiarization with a 10 c.p.s. Flicker**

	10 c.p.s.		6 c.p.s.			10 c.p.s.		6 c.p.s.	
	Before	After	Before	After		Before	After	Before	After
VIS (4)	1.5	1.5	1.0	1.0	RF (2)	1.5	0.5	2.0	1.5
					CL (3)	1.0	0.0	1.5	1.5
LG (4)	2.0	1.8	2.5	2.5	MSS (4)	1.5	0.8	1.0	0.5
					VH (3)	0.7	0.0	0.5	0.5
Total	2.5	3.3	3.5	3.5	DH (3)	1.0	0.0	0.5	1.0
					AL (2)	0.7	0.0	0.0	0.0
					Total	6.4	1.3	5.5	5.0

* Numbers in parentheses refer to number of animals.

TABLE 2

Labelled Responses During Familiarization and Approach Training

	VIS (N = 4)		LG (N = 4)		RF (N = 2)		CL (N = 3)		MSS-PSS (N = 4)		AUD (N = 1)	
	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S
FAMILIARIZATION (10/S)												
Before	1.5	1.0	2.0	2.5	1.5	2.0	1.0	1.5	1.5	1.0	2.0	—
After	1.5	1.0	1.8	2.5	0.5	1.5	0.0	1.5	0.8	0.5	1.0	—
APPROACH TRAINING (10/S-S^D)												
After first milk	2.0		2.0		1.5		1.5		0.5		—	
After steady lever press	1.0		1.5		1.0		0.7		0.8		0.5	
Middle of 10/S training	1.8		2.0		1.3		1.3		0.8		1.0	
End of 10/S training	2.8		2.3		2.0		2.3		0.8		1.0	

	VH (N = 3)		DENTATE (N = 1)		DH (N = 3)		FORNIX (N = 1)		AL (N = 2)		ABM (N = 1)		HYPO (N = 1)	
	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S
FAMILIARIZATION														
Before	0.7	0.5	1.0	—	1.0	0.5	1.0	—	0.5	0.0	1.0	—	2.0	—
After	0.0	0.5	1.0	—	0.0	1.0	0.0	—	0.0	0.0	0.0	—	0.0	—
APPROACH TRAINING (10/S-S^D)														
After first milk	1.0		—		1.5		—		0.0		—		—	
After steady lever press	0.0		1.0		0.3		0.0		0.0		0.0		0.0	
Middle of 10/S training	0.0		3.0		0.3		2.0		0.0*		0.0		0.0	
End of 10/S training	0.7		3.0		1.0		3.0		0.5		0.0		1.0	

— = no responses recorded.

* = 40 c.p.s. bursts were observed intermittently in amygdala from this stage on.

Note: Each entry in table is an average of 4 to 12 records from each of N animals, scored as indicated in text.

were observed from the derivations: reticular formation (RF), centralis lateralis of the thalamus (CL), ventral hippocampus (VH) and dorsal hippocampus (DH). No change in the amounts of labelled responses occurred in amygdala (AL) and association cortex (MSS) (Table 2).

After steady lever pressing. The animals, at this stage, have perfected the motor response of pressing the lever to obtain milk and have developed a steady, characteristic rate of responding. The TCS has not been associated systematically with the occurrence of reinforcement. Throughout this period and during the early stages of introduction of the TCS reinforcement contingency, the amount of labelled response diminished *below* the incidence level seen after the first presentation of milk in all structures except MSS. In the latter recordings there was a slight increase. The scores of labelled responses from VIS, LG, MSS, and VH were as low or lower than those observed at the end of the familiarization period. Recordings obtained at this time are depicted in the upper portion of Figure 1.

At the advent of the TCS reinforcement contingency (and for some time thereafter) the operant rate became markedly elevated. Such a change would be expected from the substitution of an aperiodic schedule of reinforcement for a periodic schedule.

Middle of 10 c.p.s. training. As the milk reinforcement was made contingent on lever-pressing during the TCS, the incidence of labelled responses to the TCS increased in VIS, AUD, LG, RF and CL. No change was observed in VH, DH, MSS, HYPO, AL, ABM, FX or DENT.

An interesting demonstration of stimulus

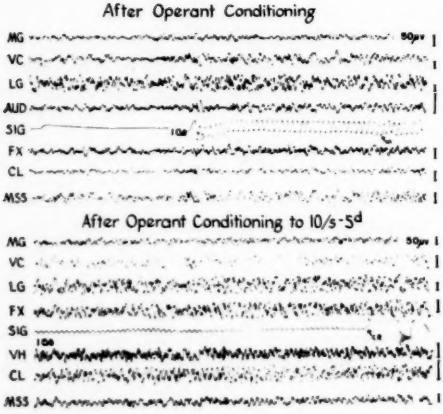

FIG. 1. *Top:* recording obtained after operant conditioning, when the cats were steadily pressing the lever, on introduction of the 10 c.p.s. flicker. Arrow denotes lever press. *Bottom:* recordings obtained after the lever pressing response was brought under control of the 10 c.p.s. flicker as the discriminative stimulus (S^D). Arrow denotes lever press.

(MG—medial geniculate body; VC—visual cortex; LG—lateral geniculate body; AUD—auditory cortex; SIG—record of conditioned stimulus and conditioned response; FX—fornix; CL—centralis lateralis; MSS—medial suprasylvian gyrus; VH—ventral hippocampus.)

control occurred with the two animals subjected to periods of darkness between presentations of the flickering light. As the number of intertrial responses decreased, the amount of labelled responses leveled off at a score approximately as stated for "Middle of Training," Table 2. At this time, presentations of steady light elicited the behavioral response with the same probability and latency as presentation of the TCS. It was not until the procedure was altered to use steady light as the background that the amount of labelled response increased in proportion to the decrease in responses during the intertrial period.

End of 10 c.p.s. training. When good stimulus control of the behavior was achieved, lever-pressing occurred rarely during the intertrial period but almost invariably when the TCS was presented. A generalized increase in labelled response was observed in all leads except AUD, AEM, DENT and MSS, and was most marked in VIS, FX, RF, and CL. In the latter structures the responses were greater than those seen in naive animals on first presentation of the TCS. Typical records are shown in the lower portion of Figure 1.

DIFFERENTIAL TRAINING

When good control of the behavior by the 10 c.p.s. flicker had been achieved, differential training was initiated. Lever presses in response to 10 c.p.s. flicker (S^D) were reinforced with milk but those in response to 6 c.p.s. flicker (S^{Δ}) were not. Table 3 summarizes the amounts of the labelled responses observed in response to both flicker frequencies throughout this procedure.

Early in differential training, the amount of labelled potentials from all structures observed during correct behavioral responses to the 10 c.p.s. flicker (S^D) was essentially the same as at the end of the approach training. In contrast, when lever pressing did not occur (*an error of omission*), labelled potentials were diminished in VIS, LG, CL, VH, FX, DENT and AL. Labelled responses to the 6 c.p.s. flicker (S^{Δ}) were generally fewer than to the 10 c.p.s. flicker and tended to be less marked if lever pressing occurred (*error of commission*) than when no lever press occurred (appropriate behavior).

When appreciable discrimination had been achieved between the two stimulus frequencies, the labelled responses to the 6 c.p.s. flicker (S^{Δ}) were generally as marked as to the 10 c.p.s. flicker (S^D). This increase on presentation of the S^{Δ} was most apparent in recordings from VIS, RF, CL, MSS, VH and DH with generally lower scores during inappropriate behavior. In contrast to the increase in response to the S^{Δ}, slight increases in labelled responses were recorded in MSS, VH, DH, DENT and HYPO in response to S^D and were more independent of the appropriateness of the behavior. It is of interest to contrast the amount of labelled responses

TABLE 3

Labelled Responses During Differential Training

	VIS (N = 4)		LG (N = 4)		RF (N = 2)		CL (N = 3)		MSS-PSS (N = 4)		AUD (N = 1)	
	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S
DIFFERENTIAL TRAINING (10/S-S^D, 6/S-S^Δ)												
Early training												
Correct	2.5	1.7	2.3	2.3	2.0	1.5	2.0	1.0	1.0	0.7	2.0	3.0
Error	1.8	1.1	2.0	2.3	1.5	1.0	1.7	1.3	1.0	1.3	2.0	3.0
Late training												
Correct	2.5	2.3	2.3	2.3	2.0	2.0	2.0	1.7	2.0	2.0	2.0	2.0
Error	2.0	1.8	2.3	2.0	2.0*	1.5	1.3*	1.3*	2.0	1.5	2.0	2.0
SATIATION (10/S)	2.3†	2.3	2.0	2.5	2.0	2.0†	1.3	2.0	1.8	2.5	1.0	2.0

	VH (N = 3)		DENTATE (N = 1)		DH (N = 3)		FORNIX (N = 1)		AL (N = 2)		ABM (N = 1)		HYPO (N = 1)	
	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S
DIFFERENTIAL TRAINING (10/S-S^D, 6/S-S^Δ)														M.
Early training														
Correct	0.7	0.0	2.0	—	1.0	1.5	3.0	—	0.5	0.5	1.0	2.0	1.0	3.0
Error	0.0	0.7	1.0	2.0	1.0	1.0	2.0	2.0	0.0	0.0	1.0	2.0	2.0	2.0
Late training														
Correct	1.0	1.0	3.0	3.0	1.3	2.0	3.0	3.0	0.0	0.0	1.0	1.0	2.0	1.0
Error	0.3	1.0	2.0	3.0	1.0	1.7	2.0*	2.0*	0.0	0.0	1.0	1.0	2.0	1.0
SATIATION (10/S)	1.0	0.7	1.0	3.0	1.0	1.7	1.0	3.0	0.0	0.0	2.0	2.0	2.0	2.0

† = Some animals showed frequency doubling at this stage.

* = Potentials at approximately both frequencies were repeatedly observed.

Note: Each entry in table is average of 4 to 12 records from each of N animals, scored as indicated in text.

observed during a correct behavioral response to a particular TCS with the amount observed during erroneous behavior to that same TCS. As may be noted from Table 3 for Early Training, in 13 cases the labelled responses were greater during correct response, in seven cases no difference was evidenced, and in four cases the labelled responses were greater during incorrect behavioral responses. When the discrimination was well-established 13 cases showed greater labelled responses during correct behavioral responses, 13 cases showed no difference, and no cases occurred where labelled responses were greater during inappropriate behavior. These differences are sufficiently marked that they are discernible as a consistent trend even if the data from all derivations are pooled (Table 5).

The foregoing data indicate that the amount of labelled potentials, *i.e.*, potentials at the same frequency as the TCS or its harmonics, diminished during erroneous performance irrespective of the TCS presented or the behavior required of the animal. It might be reasoned that electrical events in the central nervous system associated with the motor performance of a given response would mask or enhance labelled electrical responses to a given TCS. This might account for the difference in the amount of labelled responses depending upon whether or not the behavior was appropriate, were it not for the fact that different motor responses were associated with correct behavior for each TCS. Examination of the EEG records suggested another explanation for the reduction in labelled responses when the

behavior was inappropriate. From the records obtained late in the differential training procedure there was indication that *in some structures, during erroneous performance at this stage, a shift in the frequency of the recorded potentials occurred toward the frequency of that TCS which was compatible with the behavioral response.* The S^D, 10 c.p.s. flicker, was compatible with the lever pressing response; the S^Δ, 6 c.p.s. flicker, was compatible with the non-lever pressing response. When no lever press was performed during presentation of 10 c.p.s. flicker (error of omission), labelled responses at 10 c.p.s. frequency diminished and slower potentials varying between 5–6 c.p.s. could be observed (lower portion of Figure 2). This is most apparent by comparing VIS, FX and CL in the top tracings, where an appropriate response occurred at the arrow, to the same leads in the bottom set of tracings.

The converse of this phenomenon is depicted in Figure 3. When an error of commission occurred during presentation of the 6 c.p.s. TCS, labelled responses at 6 c.p.s. diminished and potentials at approximately 10 c.p.s. could be observed. Again the derivations most clearly demonstrating this are VIS, FX and CL. In particular the potentials at approximately 10 c.p.s. in CL after onset of the TCS should be noted.

In addition to the slow activity at 5–6 c.p.s. in FX and CL during incorrect performance to 10 c.p.s. flicker (error of omission) there appeared slow hypersynchronous activity at about the same frequency in the dorsal hippocampal derivation (DH). This activity was never observed in the ventral hippocampal (VH) derivation. The appearance and persistence of slow activity in these three leads had a remarkable predictive value and almost invariably indicated that the animals would not respond.

The sequence of electrical changes in these three leads, DH, CL and FX, when a correct response was elicited to the 10 c.p.s. flicker is worth describing in detail. When the slow activity, evoked at the onset of the TCS, disappeared from all three leads, labelled responses appeared in CL and FX. Shortly thereafter the "wavelike" characteristic changed to be more "spike-like" in nature. Recordings from VIS showed a similar shift in wave form and a lever press was performed within the following few seconds.

Data obtained after satiation re-emphasize the difference in labelled responses when behavior was appropriate or inappropriate.

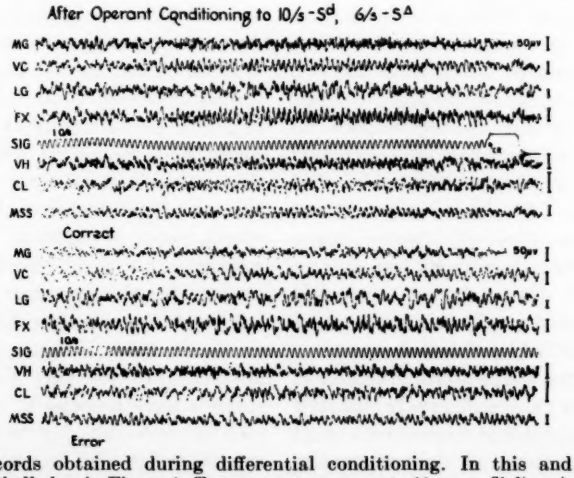

FIG. 2. Records obtained during differential conditioning. In this and subsequent figures leads labelled as in Figure 1. *Top:* correct response to 10 c.p.s. flicker. Arrow denotes lever press. *Bottom:* error of omission to 10 c.p.s. flicker.

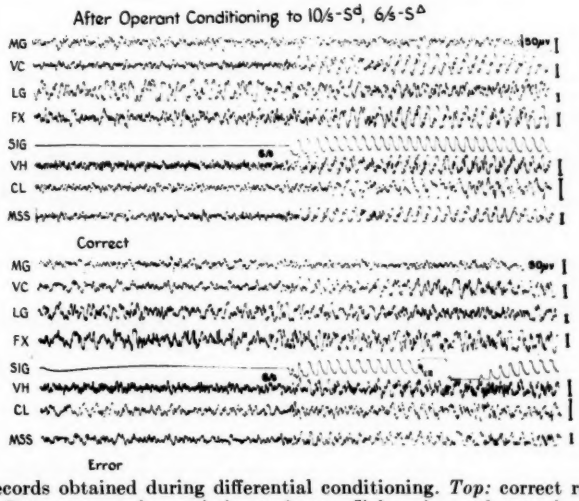

FIG. 3. Records obtained during differential conditioning. *Top:* correct response to 6 c.p.s. flicker. *Bottom:* error of commission to 6 c.p.s. flicker. Arrow denotes lever press.

The animals were allowed to drink milk *ad libitum*. Records were taken when they refused more milk and presentation of either TCS elicited no lever press. It is re-emphasized that *no* lever response was appropriate for the S$^\Delta$ and inappropriate for the S^D. The score for labelled responses to the TCS of 6 c.p.s. was maximal in most structures while minimal to 10 c.p.s. in most structures.

DIFFERENTIAL APPROACH-AVOIDANCE TRAINING

Data gathered throughout these procedures are summarized in Table 4. As a comparative baseline, records were obtained in response to both TCS's before shock was introduced but with the lever removed from the chamber. As expected, the scores to the S^D approximate those during errors of omission. However, during presentation of the S$^\Delta$ the amounts of labelled response approximated those during correct response.

After the first set of shock experiences was associated with 6 c.p.s. flicker, labelled responses increased to presentation of both frequencies in ABM, AL, DH, VH and VIS while slight decreases were observed in RF and MSS. An increase in labelled response to the S$^\Delta$ was also seen in CL and LG.

As training progressed, discriminative behavior was good in the approach phase. The lever pressing response was maintained to the 10 c.p.s. TCS, and the CAR was elicited only rarely to the occasional 6 c.p.s. TCS presentations introduced in this phase.

In contrast, discriminative behavior was poor in the avoidance phase. Although lever pressing to the 10 c.p.s. TCS was quite rare, hurdle-jumping to this frequency occurred rather frequently. Hurdle-jumping to the 6 c.p.s. TCS became almost invariable, and lever pressing to this frequency practically never occurred.

A gradual overall increase in the amounts of labelled responses to either TCS was noted during the avoidance phase as the CAR was established (Tables 4 and 5). There appeared to be relatively slight differences between the overall amounts of labelled responses elicited by the two frequencies. As indicated in Table 4, labelled responses at multiples of the frequencies as well as labelled potentials at both frequencies were repeatedly observed in many structures to both TCS's.

As the conditioned emotional response (CER) was established, slightly more labelled responses were observed when the

TABLE 4

Labelled Responses During Differential Approach-Avoidance Training

	VIS (N = 4)		LG (N = 4)		RF (N = 2)		CL (N = 3)		MSS-PSS (N = 4)		AUT (N =)	
	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S
APPROACH (10/S)—AVOIDANCE (6/S)												
Before first shock (lever and dish out)	2.3†	1.8†	2.3	2.3	2.0†	2.0†	1.3*	1.7	2.0	1.8	2.0	2.0
After first shock	2.8	2.8†	2.3	2.8	1.5*	1.5	1.3*	2.3	1.8	1.8	2.0	2.0
0% CAR (CER)												
AVOIDANCE PHASE	2.8†	2.7†	2.8	2.8†	2.0†	1.5†	2.0†	2.0†	2.0	2.3	2.0	2.0
APPROACH PHASE												
Correct	3.0†	2.3*	2.8	2.7	2.0†*	0.0	2.0*	2.5	2.0*	2.5	2.0	2.0
Error	2.5†*	2.0*	2.8†*	1.7*	2.0*	1.0*	2.3*	2.0*	2.0	1.0*	3.0	2.0
25% CAR												
AVOIDANCE PHASE	2.3	2.5	2.5*	2.3	2.0*	2.0*	1.3*	1.7*	2.0	2.0	2.0	3.0
APPROACH PHASE												
Correct	2.8	2.5	2.3	1.5	2.0*	—	2.0*	3.0	2.0	2.5	2.0	2.0
Error	2.5	2.3	2.3	2.0	2.0*	1.5	2.0*	2.0	2.0	2.0	2.0	—
75% CAR												
AVOIDANCE PHASE	3.0†*	3.0†	2.0	2.0	3.0*	3.0	2.0	2.0	3.0	3.0	2.0	3.0
APPROACH PHASE												
Correct	2.7†	3.0	2.0	2.0	2.5†	3.0	2.0	2.0	2.3	2.3	2.0	3.0
Error	2.7†	3.0†	2.0	2.5	2.0	2.0*	2.0*	2.0	2.3	2.0	2.0	—
100% CAR												
AVOIDANCE PHASE	2.8†	2.8†	2.5	2.3*	2.0*	2.0*	1.7*	2.3	2.3*	2.3	2.0	3.0
APPROACH PHASE												
Correct	2.5†	2.5*	2.5	2.0*	2.0*	2.0	2.3*	2.3	2.0*	2.0	2.0	3.0
Error	2.0†*	2.3*	2.3	2.0*	2.0†*	3.0*	2.0*	2.0*	2.0	1.0*	2.0	1.0
SATIATION—100% CAR	2.3†	2.0	2.0	2.3	2.0*	2.0†	2.3*	1.6	1.8	1.5*	3.0	3.0

	VH (N = 3)		DENT (N = 1)		DH (N = 3)		FORNIX (N = 1)		AL (N = 2)		ABM (N = 1)		HYPO (N = 1)	
	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S
APPROACH (10/S)—AVOIDANCE (6/S)														
Before first shock (lever and dish out)	0.7	1.0	2.0	3.0	0.7	1.0	3.0	3.0	0.0‡	0.0	1.0	1.0	2.0	2.0
After first shock	1.3	1.3	3.0	3.0	2.0	1.7	2.0	3.0	0.5	0.5	2.0	2.0	2.0	2.0
0% CAR (CER)														
AVOIDANCE PHASE	1.0	1.0	3.0	3.0	0.7	2.0†	2.0	3.0	0.0	0.0	1.0	2.0	2.0	1.0
APPROACH PHASE														
Correct	1.0*	2.0	3.0	3.0	2.0†	2.5	3.0*	3.0	0.5	0.5	1.0*	2.0	2.0	2.0
Error	1.0	0.5	3.0	—	1.7†	0.5	3.0*	—	0.5	0.5	1.0	2.0	2.0*	2.0*
25% CAR														
AVOIDANCE PHASE	1.3	1.7	3.0	3.0	1.7*	2.0*	2.0*	3.0*	0.5	1.0	2.0	2.0	2.0	2.0
APPROACH PHASE														
Correct	1.0	—	3.0	3.0	2.0	—	2.0*	3.0	1.0	1.0	1.0	0.0	2.0	1.0
Error	2.0	0.5	3.0	3.0	2.0*	1.3	2.0*	2.0	0.5	0.5	1.0	1.0	1.0	—

TABLE 4—*Continued*

	VH (N = 3)		DENT (N = 1)		DH (N = 3)		FORNIX (N = 1)		AL (N = 2)		ABM (N = 1)		HYPO (N = 1)	
	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S	10/S	6/S
% CAR														
AVOIDANCE PHASE	0.0	1.5	3.0	3.0	2.0	2.5	2.0	3.0	0.0	1.0	1.0	2.0	2.0	2.0
APPROACH PHASE														
Correct	1.5	1.5	2.0	3.0	1.5	2.0	—	—	0.0	—	—	—	2.0	3.0
Error	1.0	1.0	2.0	3.0	2.0	1.5	—	3.0	0.0	0.5	—	—	1.0	—
0% CAR														
AVOIDANCE PHASE	2.3	1.7	3.0	3.0	1.7	2.0	2.0	3.0	1.0	0.5	3.0	3.0	1.0*	2.0
APPROACH PHASE														
Correct	2.0	1.5	3.0	3.0	2.0	2.0	3.0*	3.0	1.0*	1.0	2.0	2.0	1.0	2.0
Error	2.0	2.0*	—	3.0	2.5*	1.5	—	3.0*	0.5	0.5	2.0	1.0	1.0	1.0*
SATIATION—100% CAR	1.5	1.0	3.0	3.0	2.0	1.0	3.0	3.0	0.0	0.0	3.0	3.0	2.0*	2.0

† = Some animals showed frequency doubling at this stage.
* = Potentials at approximately both frequencies were repeatedly observed, at this stage.
‡ = 40 c.p.s. bursts were observed in amygdala from this stage on.
Note: CAR = conditioned avoidance response.
— = no records obtained.
Each entry in table is average of 4 to 12 records from each of N animals, scored as indicated in text.

behavior was appropriate with the presentation of either TCS in the approach phase as compared with the avoidance phase. When errors occurred to either stimulus in the approach phase, there was appreciably less labelled response in several structures. The decrement was most marked in LG, MSS, VH and DH during errors of commission with the 6 c.p.s. TCS.

The term CER is used here to describe an observed behavioral change to the presentation of 6 c.p.s. flicker during the early phases of CAR training. When this TCS was presented, the animals stopped all ongoing behavior, cringed, began to vocalize, and often defecated. This behavior occurred at a stage when the animal had performed no correct responses, *i.e.*, hurdle-crossing, before being shocked. With the appearance of appropriate behavior, the CER-like behavior began to wane. When the animals were fully trained (100% CAR) no vestige of this behavior was observable.

As is evident from Tables 5 and 6, the amount of labelled response to the 10 c.p.s. TCS increased during both correct and incorrect performances in the approach phase, when compared to earlier stages. In contrast, during correct responses to the 6 c.p.s. TCS the amount of labelled responses was greater than previously (excepting RF) but was less during erroneous responses, particularly in VH and DH. As the CAR became fully established, the discrepancy between the amounts of labelled responses during correct and incorrect behavioral responses to 6 c.p.s. flicker diminished.

The tendency for labelled responses to be fewer during erroneous performance to both TCS's remained throughout the CAR training procedure. Of the 88 comparisons possible, using the data in Table 5, in 35 cases the amount of labelled response was greater during correct behavior performance, in 42 cases the amount was the same whether the behavior was appropriate or inappropriate, and in only 11 cases was the amount of labelled response greater during erroneous performance than during correct performance. The overall averages of these findings

TABLE 5

Overall Labelled Responses, Weighted Averages, All Structures*

	APPROACH—AVOIDANCE (N = 4)				AVOIDANCE ONLY (N = 4)
	10/S		6/S		10/S
FAMILIARIZATION (10/S)					
Before	1.30		1.18		1.68
After	0.65		1.12		0.71
APPROACH (10/S)					
After first milk	1.10				
After steady lever pressing	0.62				
Middle 10/S training	0.89				
End of 10/S training	1.42				
	Correct	Error	Correct	Error	
DIFFERENTIAL APPROACH (10/S-S^D, 6/S-S^Δ)					
Early	1.61	1.28	1.37	1.36	
Late	1.84	1.53	1.82	1.51	
SATIATED	1.51		1.95		
Before first shock	1.42		1.66		
After first shock	1.88		2.05		1.83
APPROACH PHASE (10/S-S^D, 6/S-S^Δ)					
0% CAR	2.07	2.05	2.13	1.31	
25% CAR	1.98	1.97	2.18	1.67	
75% CAR	1.93	1.86	2.31	2.02	
100% CAR	2.13	1.95	2.08	1.79	
SATIATED	2.00		1.73		
CAR PHASE (6/S-aversive stimulus; 10/S-non-aversive stimulus)					
0% CAR	1.85		2.01		1.53
25% CAR	1.87		2.11		1.73
75% CAR	2.00		2.37		2.17
100% CAR	2.18		2.22		1.37

* Entries in the table were computed by multiplying the average responses observed in a structure by the number of animals in which the structure was monitored, then summing these values across all structures and dividing by the total number of structures.

are shown in Table 5. As with the comparable data from differential training, even with the pooling of data from all structures, the labelled response differential remains during CAR training. The difference remains about constant for the 10 c.p.s. throughout the procedure but decreases for 6 c.p.s. The overall amounts of labelled response to both TCS's increased during differential approach-avoidance training (Table 5).

The tendency for potentials observed during erroneous performance to shift toward the frequency of that TCS compatible with the behavioral response, mentioned earlier in the results of differential training, continued during differential approach-avoidance training. However, as the CAR became well established, a change in this phenomenon was observed. Particularly in FX and CL, and sometimes in RF, the initial response which was observed to the presentation of *either* TCS was a slow potential varying from 5–6 c.p.s. Superimposed on this slow potential, almost as a modulation,

TABLE 6

Changes in Average Amount of Labelled Potentials in Various Structures During CAR Training

	VIS (N = 4)	LG† (N = 4)	S. COLL† (N = 2)	AUD (N = 4)	MG (N = 2)	RF (N = 2)	VA† (N = 1)	SEPT† (N = 2)	FX† (N = 1)
FAMILIARIZATION									
Before	2.25	3.00	2.00	1.75	1.5	1.0	0.00	2.00	0.0
After	1.25	1.25	0.50	0.75	1.5	0.5	0.00	0.50	0.0
CAR									
First shock	2.75	2.25	2.00	2.00	1.0	3.0	0.00	1.50	3.0
0% (CER)	2.75	1.25	2.00	1.75	1.0	3.0	1.00	0.50	1.0
25%	2.50	2.75	2.00	2.25	0.5	2.0	0.00	0.50	2.0
75%	3.00*	3.00	1.00	2.00	3.0	1.0	1.00	2.50	3.0
100%	3.00**	2.75	1.00	1.25	0.5	0.5	2.00	0.50	1.0

	CN (N = 1)	MSS (N = 1)		HIPP (N = 1)	AMYG-(AL) (N = 2)	HYPO (N = 1)	MOTOR (N = 1)	MED-DOR (N = 1)	PREOP (N = 1)
FAMILIARIZATION									
Before	1.0	2.0		2.0	0.5	2.0	1.0	2.0	0.0
After	0.0	1.0		0.0	0.0	1.0	0.0	1.0	0.0
CAR									
First shock	0.0	3.0		0.0	0.0	2.0	2.0	2.0	0.0
0% (CER)	1.0	2.0		3.0	0.0	2.0	0.0	0.0	0.0
25%	2.0	2.0		2.0	0.5	3.0	0.0	0.0	0.0
75%	2.0	2.0		1.0	1.0	3.0	2.0	0.0	2.0
100%	0.0	2.0		0.0	1.0***	1.0	0.0	0.0	0.0

Notes: Numbers in parentheses refer to number of animals providing data.
CER—cringing, growling, and defecation at onset of TCS.
* All four animals showed frequency tripling in records from visual cortex, at this stage.
** All four animals showed frequency doubling at this stage.
*** Bursts of forty second activity appeared at this stage.
† Histological confirmation lacking on one animal.

a faster potential at approximately 10 c.p.s. could sometimes be observed. This modulating potential at times became so marked as to dominate the record. A period of fast potentials then ensued, which would gradually diminish to be again replaced by the slower activity. Simultaneously, labelled responses at the frequency of the presented TCS dominated the response of the visual cortex. When correct behavioral response occurred, it almost invariably took place during a period when the frequency of the labelled potentials in RF, FX and CL was the same as that in VIS and in turn corresponded to the presented TCS. Characteristically, as this correspondence between the frequency of the dominant activity in the non-specific neuronal structures and in the visual cortex occurred, a change was noted in the recorded waveforms, consisting of a shift from rounded "waves" to more sharply peaked "spikes," followed one to two seconds later by performance of the conditioned response. This shift to "spikes" was seen very consistently just before behavioral performance, and eventually acquired rather remarkable "cue" value for the experimenter. In fact, the behavioral responses by the animal could be anticipated and predicted with what, at least subjectively, seemed like remarkable accuracy. Electrical responses to the 10 c.p.s. TCS, recorded late in CAR training, are illustrated in Figure 4.

Some further indication of the possible functional relevance of these various labelled potentials was obtained by studying the effects of administration of various drugs. At a number of stages in the procedures

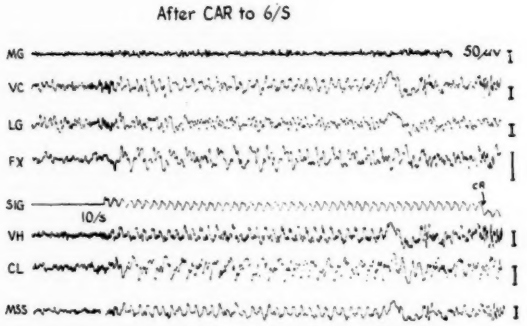

FIG. 4. Records obtained during lever press to 50 c.p.s. flicker after avoidance conditioning to the 6 c.p.s. flicker. Arrow indicates lever press.

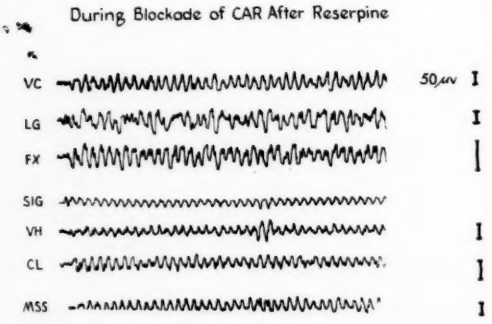

FIG. 5. Records obtained on presentation of the 10 c.p.s. flicker after performance of the conditioned avoidance response to the 6 c.p.s. flicker was blocked by injection of reserpine (100 μg./kg.).

herein described, reserpine, chlorpromazine or amphetamine were administered. The effects of these substances on behavioral and electrical responses will be reported elsewhere. Of major relevance here, however, is the fact that when performance of the CAR to the 6 c.p.s. TCS was completely blocked after administration of 100γ/kg. of reserpine, presentation of the 10 c.p.s. TCS no longer evoked the previously marked slow potentials in FX and CL, but instead resulted in the appearance of massive labelled responses at the 10 c.p.s. frequency, as shown in Figure 5.

When 0.5 mg./kg. of amphetamine was administered to this cat, the reserpine blockade of the CAR performance to the 6 c.p.s. TCS was completely reversed in a few minutes. Presentation of the 10 c.p.s. TCS once again elicited the same slow potentials in FX and CL which were previously illustrated in Figure 4.

Satiation of the animals with milk after achievement of criterion performance of the CAR elicited some changes in the amounts of labelled responses to the two TCS's in various structures, with an overall diminution of responses (Table 5).

SPONTANEOUS HYPERSYNCHRONY

In each of the animals studied during these experiments, it was observed that the characteristics of the resting EEG recorded during the intertrial intervals became markedly modified as training progressed. Particularly during the middle stages of training, when the levels of performance tended to improve rapidly, long periods of relatively high amplitude activity were frequently observed in which the frequency of this spontaneous hypersynchrony corresponded closely to the frequency of the particular TCS being employed in the training procedure. These hypersynchronous discharges sometimes dominated the resting records for entire training sessions. While they were observed in many structures, they occurred most frequently and most markedly in non-specific structures, in particular RF, FX and CL. As performance improved, the amount

of such hypersynchrony diminished. However, in the well-trained animal, it could be observed in dramatic fashion in the period immediately following an erroneous performance.

COMPARISON OF LABELLED RESPONSES IN DISCRIMINATED AND NON-DISCRIMINATED AVOIDANCE TRAINING

For purposes of comparing changes in electrical response in the avoidance phase of differential approach-avoidance training with those observed during simple avoidance training, the summarized data of a group of four cats trained to perform a conditioned avoidance response to a 10 c.p.s. TCS are presented in Table 6. The overall averages of labelled responses in these animals at the various stages of training are presented in Table 5 under the heading "Avoidance Only." Perhaps the most interesting difference between the two sets of avoidance data is that a marked diminution in the amount of labelled responses is apparent in the "Avoidance Only" group as perfect performance is achieved, whereas no such marked diminution is observed in animals performing differential responses to two discriminated frequencies.

DISCUSSION

The set of procedures described herein can be viewed as a way to achieve a series of changes in the meaning or functional significance of a stimulus. The use of a frequency-tagged conditioned stimulus has allowed a description of the distribution and characteristics of electrical events associated with the presentation of the TCS in the central nervous system as the functional significance changed.

By the use of the familiarization procedure a flickering light, at first novel, was made inconsequential. Accompanying the presentation of the potentially significant TCS to the naive animal, labelled responses appeared in numerous CNS structures, suggesting that information about the novel event was widely distributed throughout the brain. With repeated presentation, the stimulus may be considered as losing the characteristic of being novel and becoming inconsequential. This was accompanied by a diminution of labelled responses everywhere in a manner which suggested that the responses were systematically excluded from being processed. This suppression of afferent input was found not to be a generalized depression of the neural structures subserving that modality. Novel stimuli evoked responses in a manner and pattern similar to those evoked by the familiarized stimulus when the latter was novel. This differential processing was most marked in the non-specific neuronal systems as evidenced by records from RF and CL, suggesting that these structures are involved in the process of differentiation. The important role of the reticular formation in this phenomenon seems closely related to the data reported by Yoshii and Hockaday (12) in cortical conditioning and Sharpless and Jasper (11) in habituation.

The effect of the first presentation of milk to the familiarized animals appeared overtly comparable to first shock (3), in that it caused the animal to become thoroughly alert. The marked increase in labelled responses observed at this stage might be attributed to the increase of interest in the surround, which has suddenly become a source of drive reduction. The responses recorded from RF, CL, VH and DH increased most markedly at this stage, suggesting that these structures play a role in the search for a focus of attention.

When a steady lever pressing response had been established for milk, the animals were still intensely aroused and eager, but now appeared thoroughly preoccupied. The flicker serves no cue value at this stage, since reinforcement accompanies every lever press, and therefore the flicker may be considered irrelevant to the subject of concentration. Dimimution in a number of structures was

appreciable, but the most marked suppression of labelled response occurred in VH and DH.

As the presence of flicker during lever press became the contingency for reinforcement, labelled responses increased and became comparable in magnitude to those before familiarization. It is most interesting that the two cats trained in darkness during intertrial intervals showed no more marked labelled responses at criterion than did the other animals early in training. Tests of these cats using presentation of steady light showed that the lever pressing response was elicited as rapidly and as reliably as to flicker. It was interpreted that the animals were responding to the "light" attribute of the flickering light stimulus rather than to the "flicker" attribute. When the procedure for these animals was changed so as to make the intermittency of the visual stimulus the relevant attribute, the amount of labelled responses showed a marked increase, particularly noticeable in the visual structures and RF and CL.

In all animals, labelled responses became more marked as flicker became the relevant attribute of a consequential stimulus controlling a behavioral response. In contrast with the changes in labelled response configuration observed during CAR training (3), in approach training no frequency multiplying was observed from cortical derivations, no 40 c.p.s. bursts were observed in the amygdala, and labelled responses persisted in some structures (RF and HIPP) from which it disappeared in CAR acquisition.

If, at this stage, flicker stimuli of other frequencies than the TCS were presented, lever pressing occurred as rapidly and reliably as to the TCS. In other words, the behavioral response was not specific to a particular frequency of flickering light, but was generalized to a wide range of frequencies. The *intermittent* nature of the stimulus, rather than its *specific* frequency, was the relevant stimulus attribute. Differential conditioning was therefore initiated, to make the specific frequency of the TCS the relevant attribute controlling the behavioral response. As this differentiation became established, although further increases in labelled responses were observed in other structures, the most marked increment in labelled responses was observed in MSS, HYPO, VH and DH, particularly to the non-reinforced stimulus. The nature of these changes suggests that hypothalamic and rhinencephalic structures may respond to a stimulus in a fashion which depends somewhat on the *outcome* of its presentation, and that the suprasylvian gyrus is somehow involved in precise visual frequency discriminations.

The tendency for labelled responses to be clearer during correct response than during errors, and the shift in frequency of observed potentials toward the frequency of the appropriate TCS during errors, suggest further that these labelled responses are related to the processing of information. These tendencies persisted throughout the subsequent differential approach-avoidance training.

The differential effects of satiation with milk on the amount of labelled responses to the two TCS also suggest that the amount of labelled responses is related to the functional relevance or utility of information about the TCS. One might assert that the 10 c.p.s. TCS was irrelevant after satiation, since the lever pressing response was inhibited, whereas the 6 c.p.s. TCS was still relevant in that the non-lever pressing response remained functional.

Differential approach-avoidance training was instituted at this stage to investigate the consequences of attaching somewhat more forceful aversive characteristics to the 6 c.p.s. TCS, already the negative or non-reinforced stimulus for lever pressing. The general similarity of the LR configuration in the approach phase during CAR training to that observed during the preceding discrimination training suggests that the basic

aversive characteristics of the 6 c.p.s. TCS were already established and that CAR training consisted largely of associating a new motor response to an already differentiated aversive stimulus. Some quantitative changes in LR ensued, but the basic qualitative aspects of the response configuration were unaltered. The animals continued to discriminate well during the approach phase.

General activation, brought about by the first shock experience in CAR training, caused a marked and general increase of labelled responses. As the CAR became established, the configuration of labelled responses underwent a complex variation, suggesting changes in the mode of processing of information about the TCS. The present results confirm the essential aspects of our previous report (3), as do the recent findings of Liberson *et al.* (8). With respect to the report of disappearance of labelled responses at criterion which was reported by Liberson, some discrepancies exist. Although some diminution from peak labelled responses can be seen in many structures, labelled responses are still clearly visible. The discrepancy might be due to the fact that the procedure followed by Liberson involved darkening the apparatus between trials, or might be due to the absence in his procedure of any necessity for frequency discrimination.

In contrast, the cats seemed to "play safe" in the avoidance phase. The most probable behavior to either TCS was performance of the CAR. Frequency multiplying and amygdala 40 c.p.s. bursts were again observed, as in simple CAR training. Under the present conditions, however, labelled responses failed to diminish in structures such as the RF, as performance of the CAR reached criterion. In view of the continued involvement of these structures in mediating differential responses to the two TCS in another behavior, the persistence of LR in these structures would seem to be expected.

The tendency for potentials in FX and CL, at the onset of a TCS, to be initially slow is compatible with the known prepotency of avoidance over approach tendencies in the cat, as shown by conflict studies. The marked increase in appearance of the slow potentials to the fast 10 c.p.s. TCS, as CAR training proceeded with the slower 6 c.p.s. TCS, suggested that the slow potentials in FX and CL were related to the strongly aversive characteristics attached to the slow TCS by the training. This inference received support from the observation that the slow potentials recorded from FX and CL on the presentation of the 10 c.p.s. TCS disappeared when the performance of the CAR to the 6 c.p.s. TCS was blocked by reserpine, and reappeared when the reserpine effect on the CAR was reversed with amphetamine.

Observation that the slow potentials in CL were correlated with slow potentials in the dorsal hippocampus raises the problem of whether the slow potentials are to be considered as a representation of the slow frequency of the 6 c.p.s. TCS which has acquired aversive characteristics or as merely reflecting the inherent characteristics of hippocampal response cueing the orientation reflex, in accordance with the data of Grastyan (1), or as the "arousal response" of the hippocampus, described by Green and Arduini (2). The ultimate resolution of this question must be deferred, of course, until repetition of these experiments with a different choice of frequencies. However, the alternative explanations of the slow potentials seem questionable because of the differential response of dorsal and ventral hippocampus, because of the absence of these slow potentials during periods of arousal and orientation reflex earlier in the procedure before the 6 c.p.s. TCS acquired aversive characteristics, and because of the observation of fast potentials during errors of commission, as well as slow potentials during errors of omission.

The fact that spontaneous hypersynchrony, at the frequency of the TCS, appeared early in training of all animals, was maximal during periods of rapid improve-

ment in performance midway in training, and diminished as performance optimized, to reappear only sporadically after errors, seems to support the suggestion that these hypersynchronous spontaneous discharges, or assimilated rhythms, are representations of previously experienced stimuli which serve a function related to the memory trace (3, 4).

A detailed presentation has been made elsewhere (5) of a further line of evidence supporting the assertion that repeated experience with a stimulus which has definite temporal patterning causes the formation of a neural system with the capacity of discharging spontaneously with the temporal pattern of the stimulus *in the absence of the stimulus*, thus serving as a representation of previous experience.

The possible functional role of such spontaneously generated rhythms, as well as those labelled responses elicited by presentation of a TCS to a conditioned animal, is suggested by the work of Livanov *et al.* (9), Neff *et al.* (10), and Liberson *et al.* (8), all of whom have reported that direct electrical stimulation of various brain structures at the same frequency as the frequency of a visual or auditory TCS, used in establishing the learned behavior, resulted in performance of the learned response. This set of findings would suggest a clear causal role for labelled responses as such in producing an adaptive behavioral response. That is, these data suggest that the labelled responses which we observe may not be a mere correlate of information processing, or a carrier wave bearing discrete information as some sort of modulation, but rather that the labelled response itself may be the information.

A general interpretation of the salient findings of this research in terms of useful hypotheses is as follows.

1) Clear changes in the amount and distribution of labelled responses to tracer conditioned stimuli have been observed in a number of different experimental situations.

2) The amount and location of labelled responses are related to a) the *nature of the outcome* of the stimulus presentation, that is, the dimension of drive or valence, b) the *functional relevance* of the TCS as a cue for adequately motivated behavior, and c) the significance of frequency as the *relevant attribute of the stimulus for control of the behavior*.

3) Increases in labelled responses are observed with increases in the cue value of the TCS, particularly with respect to its frequency. This suggests that labelled response relates to the processing of information.

4) Changes in resting electrical activity, observed during learning, show a shift toward hypersynchronous discharges related to the TCS frequency. The widespread evidence for this phenomenon suggests that such assimilated patterns serve as a representation of the experience, or engram. The neural system which mediates this internalized representation is largely located in nonspecific structures.

5) Non-specific structures seem to play a central role in the sequence of changes in magnitude of labelled responses with experience. Evidence of differential suppression after familiarization, the major signs of assimilated rhythms, the major increments in labelled responses during approach training, clear shifts in frequency of labelled responses during errors in differential approach training—all were seen in these structures.

6) The present data seem compatible with the hypotheses that a) the role of the primary sensory systems may be conceived of as the central propagation of information representing the present state of the environment to a particular cortical region; b) this information is compared, via the diffuse projection system, with a representation of past experience activated in the rhinencephalon and the reticular formation by the similarity between past and present environment, modified by the state of the organism in terms of affect and drive level;

c) appropriate selective performance of adaptive behavioral responses depends on a sufficient congruence between the central representation of present experience and that of past experience; d) the necessity for congruence measurement of temporal patterns implies a coincidence detection mechanism, the location of which is unknown.

REFERENCES

1. Grastyan, E. In: Brazier, M. A B., ed. *The Central Nervous System and Behavior, Transactions of the Second Conference,* pp. 119–140. Josiah Macy, Jr., Foundation. 1959.
2. Green, J. D. and Arduini, A. Hippocampal electrical activity in arousal. J. Neurophysiol., **17:** 533–557, 1954.
3. John, E. R. and Killam, K. F. Electrophysiological correlates of avoidance conditioning in the cat. J. Pharm. Exp. Therap., **125:** 252–274, 1959.
4. John, E. R. and Killam, K. F. Some effects of conditioning on the electrical activity of the brain. In *Cerebral Dysfunction and Mental Disturbance.* In press.
5. John, E. R. and Killam, K. F. Studies of electrical activity of brain during differential conditioning in cats. In: Wortis, J., ed. *Recent Advances in Biological Psychiatry,* pp. 138–148. Grune & Stratton, New York, 1960.
6. Killam, K. F. In Abramson, H. A., ed. *Neuropharmacology: Transactions of the Fifth Conference,* pp. 131–198. Josiah Macy, Jr., Foundation, 1960.
7. Killam, K. F. and John, E. R. Effects of familiarization on electrical responses to stimuli. In preparation.
8. Liberson, W. T., Ellen, R. and Cadell, T. EEG studies during avoidance conditioning in rats. In: *Recent Advances in Biological Psychiatry,* pp. 158–171. Wortis, J., ed. Grune & Stratton, New York, 1960.
9. Livanov, M. N. and Korolkova, T. A. The influence of inadequate stimulation of the cortex with induction current on the bioelectrical rhythm of the cortex and conditioned reflex activity. Zh. Vyss. Nerv. Deiat., Pavlov., **3:** 332–346, 1951.
10. Neff, W. D., Nieder, P. C. and Oesterreich, R. E. Learned responses elicited by electrical stimulation of auditory pathways. Fed. Proc., **18:** 112, 1959.
11. Sharpless, S. and Jasper, H. H. Habituation of the arousal reaction. Brain, **79:** 655–680, 1956.
12. Yoshii, N. and Hockaday, W. J. Conditioning of frequency characteristic repetitive electroencephalographic responses with intermittent photic stimulation. EEG & Clin. Neurophysiol., **10:** 487–502, 1958.

SOME PARALLELS BETWEEN SEXUAL AND DOMINANCE BEHAVIOR OF INFRA-HUMAN PRIMATES[1] AND THE FANTASIES OF PATIENTS IN PSYCHOTHERAPY[2]

A. H. MASLOW, PH.D.,[3] H. RAND, M.D. AND S. NEWMAN, M.A.

It is our purpose in this paper to present some parallels between human and infra-human primates in respect to dominance-subordination, and to male and female sexuality and character, that have arisen in our own work.

What appears openly in the behavior of these animals often shows an astonishing resemblance to the content of secret human wishes and fantasies, dreams, myths, characterological adaptations, neurotic and psychotic acts and symptoms, as well as overt and covert social and psychological interactions especially between parent and child, male and female, therapist and patient, and in general, between the strong and the weak, the rulers and the ruled.

Thus, this resemblance offers a perspective on aspects of human psychology not easily accessible to behavioral observation.

We wish to stress as strongly as we can that we are dealing with interesting and suggestive *parallels*, not with proofs of anything. Monkeys and apes prove nothing whatsoever about human beings; but they *suggest* a great deal, as we can testify. These parallels have certainly enriched *our* perceptions, giving another dimension to many human psychological problems, enabling us to see much that we had not noticed before. They have also raised many questions, speculations, and hypotheses which were new for us, and which, of course, await validation by other techniques.

This is quite definitely an intellectual game we are playing and is quite appropriate, even perhaps necessary, at the idea-producing level of scientific work, at the level of "primary process creativity" (10). It is certainly necessary to be cautious in science and we wish to be, too (especially by our stress on *parallels*). But it is not well to be *only* cautious. A certain boldness in the forward elements of science, in speculation and theories, is also needed.

THE DOMINANCE-SUBORDINATION SYNDROME IN INFRA-HUMAN PRIMATES

This syndrome may be generalized to all infra-human primates and indeed, in its basic schema, to most other animals. It has been described for all vertebrate classes from the Teleost fishes to the human being, (except for amphibians). For our purposes, however, it is most useful, to begin with, to concentrate on the *Old* World monkeys and baboons in whom the syndrome is seen most nakedly in its sado-masochistic form. Apes and New World monkeys vary in certain respects described in a previous communication (8) and may be postponed for later consideration.

In brief, it is observed that when a pair of monkeys are introduced to each other for the first time, they will, without exception, form at once into a dominance-subordination hierarchy; *i.e.*, one will assume the status of boss or overlord and the other will become the subordinate one. Under experimental conditions this status is independent

[1] No effort has been made to survey the entire literature on this subject: this paper is based almost entirely on the investigations of the senior author listed in the references (2–16).

[2] Adapted from an address given before the Massachusetts Psychological Association, February 16, 1960.

[3] Department of Psychology, Brandeis University, Waltham 54, Massachusetts.

of gender. Either male or female can become either the dominant or the subordinate individual. Where there is a real discrepancy in size the larger one will usually be the dominant. Sexual dimorphism therefore almost always guarantees male dominance in the wild. In the laboratory, however, one can select as one pleases. If a female is selected who is larger than the male, she becomes dominant and he becomes subordinate. So also when two males or two females are paired, the larger one ordinarily becomes dominant. Since prior to these experiments only observations in the wild or in herds or flocks were available, we can understand why it should have been believed that dominance was an exclusively male prerogative. When the factor of size is ruled out by pairing equally large monkeys, more subtle determinants emerge into view. Sureness, lack of hesitation, a confident posture, cockiness —in short, what the observer is irresistibly impelled to call self-confidence, determines the issue. It is as if the animals somehow knew at first glance which was dominant and which subordinate. Since there are two animals involved, sometimes it looks as if this occurs by one animal conceding dominance, sometimes by one animal assuming or taking dominance, but more often these two attitudes are assumed simultaneously. Characteristically one maintains a level stare and the other drops his eyes or looks off to a corner. The postures become different, the subordinate one assumes a craven and appeasing attitude, his tail drooping, his belly closer to the floor. He looks hesitant and uncertain. He may chatter in fear or back into a corner or get out of the way.

Often, however, the difference in status shows itself very soon by a pseudo-sexual act. The subordinate animal, whether male or female, presents (assumes the female sexual position); the dominant one, whether male or female, mounts. This must be called pseudo-sexual because most often it is a token act. Sexual excitement may not be seen. Erection may be absent in the mounting male. There may be no pelvic thrusts or they may be weak and nominal. The head may be mounted instead of the pelvis, etc. There may be no penetration. The only desideratum at times seems to be getting above the subordinate, regardless of its posture or position. Sometimes the subordinate animal goes eagerly or willingly into this situation; sometimes reluctantly. In a few cases, reluctant subordination shows itself by an assumption of a face-to-face sexual position rather than the presenting for dorso-ventral mounting. This kind of dominance mounting and subordinate presenting probably occurs more often at the beginning of a relationship rather than after status has been stabilized.

In addition, the dominant animal preempts the food supply without opposition. It can and does bully the subordinate animal in various ways. But this, too, occurs much less often in a stable relationship. The dominant animal preempts *anything* that is desirable—the best place to sit, a new object in the cage, the front of the cage, etc.

Within the limits of observation of pairs in zoo or laboratory this relative status is normally permanent. It has been observed to change when females come into heat and readjustments take place (15), or when alliances of several subordinates occur to dethrone an overlord (4). There have also been reports of changes under certain experimental conditions; *e.g.*, hormone injections, traumatizing, drugs.

DOMINANCE-SUBORDINATION IN HUMANS

In sub-primate species, dominance may involve actual use of physical strength as it does, for example, in the gang or group of pre-adolescent or adolescent boys. Punching or formal boxing may establish a boy in the dominance hierarchy: often the combat takes the form of wrestling, which is won when the winner lies on top of the loser for specified amounts of time, frequently defined

by counting, or by admission of defeat ("say 'uncle' ").

But the very *threat* of use of force, or an obvious external evidence—bigger size, obvious self-confidence, strong muscles, swagger, strutting or cockiness—may be enough, as it is in monkeys. This again we may observe among boys; also in pre-adolescents of both sexes, when some girls may try to measure up their strength against boys, but eventually acknowledge that boys are stronger. This is also accepted tacitly by most children in regard to their parents and other adults.

In later life also the struggle for dominance manifests itself in all areas of interpersonal relationships: both in overt behavior, in dreams, fantasies, neurotic and psychotic symptoms. However, in the sexual realm especially we can see parallels between our data from primates and human behavior patterns and fantasies.

If maturation does not result in a healthy integration under the hegemony of genitality, masculine sexual activity may be identified with dominance, control, manipulation, aggression and even sadistic behavior. This may extend over a wide range of phenomena. At the extreme, the partner may be bound and actual pain inflicted. Or he may be immobilized, made passive, manipulated, dominated, used. Here, as in the dominance struggle of the primates, the power, dominance and aggression aspects overshadow the genital drives and use them to channel through. The pattern of the struggle is basically non-sexual, regardless of the gender of the participants. Thus in the dominance struggle there are several possible combinations:

1. Male-male relationship
2. Female-female relationship
3. Male-female relationship in which the man is dominant
4. Male-female relationship in which the woman is dominant

Cases 3 and 4 are often deceptive and masquerade frequently as the "normal" genital adjustment.

Yet even here, in the behaviorally "normal" sexual act, dominance and subordination fantasies are often found:

1. A case of a homosexual woman, whose strong masculine aspirations appeared in the course of treatment, spontaneously found herself in her first hetero-sexual experience, on top of her male partner, feeling herself as the thrusting dominant one.

2. A male patient with an anaesthetic penis seeks out sexual intercourse to feel powerful; he has repetitive fantasies of wielding a whip over a harem of women.

3. A patient reports fantasies of sucking the breast during "normal" intercourse. Even though his behavior is dominant his fantasy is submissive.

4. An active homosexual woman feels that the climax of her seductive campaign has been reached when an innocent girl succumbs sexually, *not* when she herself has sexual pleasure. Indeed, it is almost irrelevant for her.

In the behaviorally "normal" (to the eye of the camera) sexual intercourse, the fantasies may express a dominant-subordinate impulse, rather than a love, a sex or reproductive impulse. One way in which this is commonly reflected is in the use of the words screwing, fucking, to express overpowering aggression, contempt, conquest, assumption of the dominant status or even cruelty. These words are used in many non-sexual situations. "Did I get screwed!", a man may exclaim to say that he was taken advantage of. "I got 'raped' ", (or "shafted"), a man or woman may say in situations in which he or she was taken advantage of, fooled, swindled or exploited; or of an irritatingly superior or hoity-toity woman, males are apt to say "She ought to be raped" as if this would humble her properly.

Human adults—consciously, preconsciously and unconsciously—frequently perceive and describe the sexual act in terms of

the infantile perception of it as the male ("overpowering, cruel, bad") doing something harmful to the female ("helpless, unwilling, weak"). The child may perceive his father as killing the mother or hurting her in the act. So also when he sees animals copulating.

The perception of the sexual act may be sado-masochistic and manipulative in its essence and express itself correspondingly in language.

This is the (masturbation) fantasy of a dominant woman.

> She is an Oriental queen, all powerful. She is surrounded by huge male slaves, almost naked. She selects one for a sexual partner and commands him to serve her. He does this in the way that she prefers, she on her back and he above her. She likes the feeling of being crushed by his weight. He is very potent and with a huge penis performs to her complete satisfaction. She lets herself go entirely in an orgiastic way.
>
> But after it is over, because he has committed lese-majeste, she commands that he be decapitated, which is done. He does not protest but recognizes that this is inevitable, proper and suitable. She then commands another slave to do the same.

This woman is frigid in actual sexual intercourse. She has the common rape and prostitution fantasies. Apparently these enable her to surrender enough to enjoy sexuality. Several of these high-dominance women who were sexually neurotic, and who "dominatized" the sexual act, managed some compromise pleasure in sexuality by such fantasies as the following:

1. By being in the above position, and insisting that the man remain immobile, these women could imagine that *they* were the males and that *they* had the penis ("as if it were part of *my* body and I were entering him").

2. The fantasy that the penis was attached to her body and that she was "screwing" him has been reported by some females even though they assumed the below position.

3. That the man was really "serving" her, was her slave, working hard, sweating and grunting at his job of pleasing her rather than himself, while she saw herself as taking her ease, not working, making no effort and secretly using him.

4. By stretching and pulling the clitoris to resemble a penis in masturbation.

5. By decontaminating the "surrender"; *i.e.*, refusing to submit (even though sexually submitting) by refusing to enjoy it, by hiding the enjoyment, by contemptuous gestures; *e.g.*, smoking casually during the act, yawning, laughing contemptuously at his excitement.

MODES OF ADJUSTMENT OF THE SUBORDINATED ONES

IN ANIMALS

"Presentation" to the dominant animal may range from a kind of symbolic gesture of recognition of the other's superiority to actual '*giving up*' of the male role in an acute situation and thus trying to escape injury and punishment by the other animal.

The completely subordinate animal flees to a far corner of the cage when food is thrown in, and thus makes it clear that he is not competing for it. To obtain food it may often engage in what Kempf (1) called "prostitution behavior", *i.e.*, it may present itself sexually to the dominant one. This it does also to avoid attack or to obtain protection. These presentations are frequently merely nominal, vestigial, one is tempted to say 'symbolic.' They are different from real sexual behavior in heat. The following responses have been observed in the subordinate animal in a dominance mounting: fear, apprehension, disinterest, mere complaisance, annoyance, impatience, passivity, cringing, waxy flexibility or attempts at flight. In many cases (but not in all) the response pattern indicates that being dominance-mounted is unpleasant.

Sexual presentation and subordination may serve as a *means* for achieving several aims that can be summarized under the headings of self-preservation and handling fear in threatening situations. This includes warding off attacks, avoiding punishment, obtaining access to food and other benefits and privileges.

IN MAN

Man learns subordinate patterns of behavior from early childhood on. While he is factually helpless he learns to submit to his parents, and to other adults. He has to do this, for his (or her) very survival depends on parental care. Also, threatening situations and fears can be handled by the child only with the help of parents (or their substitutes). The child can assert its will only if the parents let him do so and are not threatened by his asserting his will. By and large, he can strive for security, when he is young, only by being and becoming the *object* of parental love and care. He cannot really be the *subject* of masculine assertive behavior towards the parents, unless they let him; or when they do not realize that he is asserting himself by various covert compromise formations; *e.g.*, apparent inability to get the good grades in school that his parents demand.

This helpless situation, as long as the child is young, leaves deep impressions both upon the human individual and upon the cultural, artistic and social aspects of mankind.

Leonardo Da Vinci, in his notebooks mentions the (unsubstantiated) legend of the beaver[4] that pursued by enemies castrates itself, to save his life: not being a male he might be spared. So also the boy or the adult man, tries sometimes to escape the danger of competition or attack, or the threat of punishment by denial or renunciation of his masculinity.[5]

The adult, too, may use the subordinate pattern as a means of handling threats, escaping punishment, and obtaining favors and approval. In other words, such an adult will not assert his will, will not fight, compete or challenge, but rather will try to escape dangers by 'degrading' himself, by surrendering or ingratiation, by voluntary subordination and appeasement. This is not an all or none situation—there are many intermediate grades. A monkey that has to submit unwillingly may, for instance, retain some degree of dominance by facing his sexual partner rather than presenting his rear. Such compromise formations are common also in humans. Complete subordination is rare. An effort is made to preserve as much self-assertion, will, freedom, as is possible under the circumstances.

Ingratiation, continuing smilings, being unable to win, some forms of kindness—all these can be seen as attempts at avoiding danger by voluntarily accepting dominance and making clear that one is no threat to the dominant one. Other techniques are appeasement, submissiveness, fawning, humility, propitiation, meekness, lack of demandingness or challenge, whimpering, cringing, showing fear, whining, compliance, wheedling, reducing, appealing *via* incapacity, helplessness or fearfulness or illness, dependence, the call to pity, the giving of constant admiration, being "good," looking up to, adoration, worship, passivity, the "you are always right" technique. These are all accommodations whereby the subordinate child, the weaker one, can adapt him-

[4] See the discussion of the problem of masochism at the Midwinter Meeting, 1955, of the American Psychoanalytic Association, reported in the J. Amer. Psychoanal. Ass., July 1956 by Dr. Martin H. Stein, especially Rudolph M. Loewenstein's presentation in which a distinction is made between the various forms of masochism. He maintains that masochism does play a role in survival. It is "the weapon of the weak . . . of every child . . . faced with the danger of human aggression" (ibid, p. 537). Giving up dominance or masculinity can be seen as preferable to giving up life itself.

[5] This is probably a human projection only, for we do not know of animals castrating other animals: they either kill, fight, run or present. Only the human being castrates literally.

self to living with the sado-masochistic parent, the strong one. Observe that these are also customary techniques whereby a weak minority group can accommodate to a stronger group.

That these subordinance techniques ("presenting techniques") can all be seen as sexualized, is obvious, for most of these techniques may also be called "feminine" even in our culture and *are* in *fact* feminine in more traditional sado-masochistic cultures where women are valued less than men.

Weakness can appease strength and avert its dangers by sexualizing itself and by offering in a symbolic way a sexual service to the strong. Also strength and would-be strength may assert itself and prove itself *via* sexual channels.

Why does presenting and its variations work so well in appeasing and forestalling the wrath of the strong? We do not really know. We know that it does work and that we have infra-human parallels which force us to think of at least the possibility of instinctoid sources. For instance, the ethologists have described for us the "chivalry reflex" in the wolf and in the dog. Two animals may be fighting hard, even to the death. However, if one *concedes* defeat by rolling over and exposing its throat and belly, not fighting any longer, the conqueror will no longer attack but will turn away. In one or another isomorphic form, something of the sort can be seen in many other species. In the infra-human primates, it is sexual presenting which apparently has the same meaning, or at least the same appeasing and life-saving effect.

In some lower species, this is the mechanism that differentiates male from female objects for the attacking male. If it fights back, it's a male and fighting ensues; if it doesn't fight back but instead assumes another kind of posture, varying with the species, it is a female and sexual activity ensues. In some birds, the females indicate subordinance not only by assuming a sexually inviting position, but also by soliciting food from the male in the way that a half-grown fledgling does. No instance is known in which a male does this in the wild. Here also human parallels strongly suggest themselves. The appeal to many males of admitted fear, helplessness, passivity, receptiveness, etc. in the female or in the child suggests a parallel to the "chivalry reflex." Most males, especially immature males, in our culture are not sexually drawn to the female who is strong, assertive, self-confident, self-sufficient, and if he *is*, we may suspect that his feminine component is attracted to her masculine component; that is, at the unconscious and fantasy level, this may simply be a reversal of roles, for the strong woman can also be drawn to the dependent male as a man is to a woman or perhaps as a mother is to a son. Even this reminds us of the chivalry reflex. (Of course, we must not forget that in the human beings we find, in our own culture at least, that psychologically mature and strong males can be drawn to psychologically mature females who may look too "strong" for the average, more delicate male.)

DOMINANCE, SUBORDINATION, MASCULINITY, FEMININITY

The young or neurotic human being in many cultures has a tendency to identify or confuse subordinate status with feminine status and the dominant status with masculine status.

The man in subordinate status, whether willingly or unwillingly arrived at, in relation to a boss, superior officer or anybody who gives him orders, may react as if he had been made female, as if even justifiable orders were like being mounted or raped. He may respond to a realistic situation as if he had been ordered to become feminine; *i.e.*, to present. This, as in the monkeys, is without relationship to gender; *i.e.*, it may happen in response to either male or female boss. Some respond to this subordination by submitting willingly or even eagerly but these are often despised.

Army lingo examples: Such a person or act is called "brownnose," "being cornholed," "asskisser," "asslicker," "being browned." The phrase "he is prostituting himself" also applies. Other men may fight against this as if against an assault upon their masculinity, even when the demands or orders are perfectly natural or justifiable. That is, such dominance relations are sexualized just as sexual relations are seen as dominance-subordination metaphors.

Furthermore, in those cultures which value masculinity more than femininity, being pushed into subordinate status means being degraded or demoted. In such cultures this attitude is shared by both men and women. Women who feel that their femininity is synonymous with inferior status or subordination may repudiate their femininity in various unconscious ways or unconsciously emulate the male, or they may in their striving for esteem or status or self-respect fantasy being male. This is as if they thought that the only way to be strong or capable or intelligent or successful were to be male. So also, following the same assumption, the woman in order to be a good female may feel it necessary to give up her strength, intelligence or talent, fearing them as somehow masculine and defeminizing.

This has been observed overtly in female children who will openly demand some phallic equivalent; *e.g.*, will urinate in the standing position. In adults, this is not seen overtly very often (exceptions are in psychotics or in some female homosexuals) but is rather seen in fantasy or dreams of contempt or hostility or desexualizing and castrating of the male, or of various forms of resistance to being pushed into the female position, either literally or figuratively.

HOMOSEXUALITY

We have learned from Evelyn Hooker to speak of the many kinds of homosexualities and to give up monistic explanations and theories. However, the homosexual behavior that is so easily and parsimoniously explained in monkeys, that is, as a function of dominance and subordination status, can also be paralleled in *some* forms of human homosexuality, overt as well as covert. The dominating Lesbian certainly exists and she so strongly identifies the female sexual role with total domination by the male, with obliteration of her personality, her selfhood, that she could not possibly accept the role of "weakness." Feeling herself to be so strong she identifies with the conquering male. So also for the pansy type of male homosexual who feels himself to be so weak that he cannot possibly fit into *his* distorted image of the dominant male, the raper, the exploiter, the selfish, arrogant taker of what he wants. But also his sexual presenting can be a way of protecting himself or winning favors, as in men's prisons. The same mechanism may be seen in the "normal" man.

> An unconsciously passive, fearful man, ingratiating and appeasing his therapist, had the following dream: "I was following a narrow snowy path someplace in the wilds of Alaska. Suddenly there is a huge frightening bear standing on his hind legs in front of me, blocking the path. In terror I turn around and put my rear up to him, eagerly and quickly fitting his penis into my anus in the hope that he won't attack me. It works and I can go on." He was disturbed by this dream, seeing it as homosexual.

Let us say that at least *one* factor in the complex web of human homosexuality is the dominance-subordination determinant in its sado-masochistic version, in the version that so many children report and adults covertly fantasy, that "Daddy is killing Mommy" or, upon watching animals copulate, "He is hurting her." Some males cannot stand to identify with the hurter and/or prefer to identify with the hurtee. Some females cannot or will not identify with the hurtee and/or prefer to identify with the hurter.

Presumably in such cases differentiating

ex from dominance instead of confounding hem should cure *this* aspect of the illness.

SEXUALIZING OF THE TRANSFERENCE

The actual subordination of the therapeutic patient, his factual weakness, his necessary humility, the lowering of self-esteem implied in asking someone for help and in exposing oneself in all one's shame and embarrassment, leads not only to the customary hostility fantasies and verbalizations, but also encourages a sexualization of the relationship. Whatever character style or defenses the patient has lived by will reveal themselves here in a sexual translation, most often in a dominatized form. That it is will be either of raping, castrating, or otherwise dominating the analyst or, more frequently, of winning his love by offering oneself to him as a sexual object, (although of course there are also many other fantasied ways of winning his love). All this can be independent of the gender of either the analyst or the patient, just as in monkeys. "Presenting to the analyst" this may be called, and must very frequently be isomorphic with the ways in which long ago as a child, the patient "presented" to his parents, especially to the one seen as more powerful (regardless of gender). It may be hypothesized that any therapeutic atmosphere or technique which minimized the factual status of subordination would reduce sexualization of the relationship.

The patient, a 23-year old single man, had been for most of his life fearful of older men, especially those in the authoritative position. He was never conscious of any hostile feelings, wishes or fantasies toward these men; toward the original man, his father, he had the same attitude. In fact, if someone criticized his father he would passionately defend him. In analytic treatment the patient developed the same attitudes toward the analyst. He came in one day with the following dream:

He is in some kind of prison atmosphere where he is to be forced to submit to penile intercourse by some big man. The man approaches him ready to penetrate him and the dream ends.

In association to the dream the patient suddenly remembered something that had occurred the day before and represented for the first time a conscious, hostile fantasy toward an older man. When he left the analyst's office and got into his car, he saw the analyst's car nearby. His fantasy was that he wanted to crash his car into the rear of the analyst's car. This fantasy had apparently been transient and had gone into repression. The dream apparently was a projected retaliative gesture.

RELIGIOUS OBLATION

We may speak not only of the "feminine aspects of Christianity" in the Nietzschean sense (and of other religions as well). But also we can get a richer understanding of the oblative and homonomous aspects of all religious experience, and especially of the conversion experience, by separating the fusion of sexuality and dominance-subordination (pride-humility). The conversion experience as depicted by James, Begbie and many others is often described in a clearly sexual way, but also as a giving up of pride and autonomy in favor of surrender and oblation, with ensuing peace of mind in the "successful" cases. The necessary giving up of will and of self-sufficiency, as presented in these accounts, can be understood better if we are clearly aware of the simultaneous and ambitendent urges to rule and be ruled, to dominate and to submit, and if we are also aware of the delights of surrender. In the Western male, these are felt especially as dangerous to the (unevolved) conception of masculinity, are felt even as a castration, as a becoming feminine, as a homosexual reaction; *i.e.*, they are sexualized.

A patient in homosexual panic ran away and hid in a hotel room in another city. He couldn't sleep and felt frightened much of the time. Suddenly during the night,

as he lay in bed on his back, he felt the weight of a presence on top of him. He submitted to it lovingly and felt "This is God." He felt peaceful and slept deeply for the first time in months. Next morning, he awoke refreshed and relaxed and determined to serve God by good works, which he now does. He returned to his wife and is heterosexual with her.

We may hypothesize that man's bisexual or ambitendent urges (to be masculine and feminine simultaneously *or*, what amounts to the same thing, to master and to submit) are generally dangerous to him because he interprets femininity as submission, and submission as feminine, feels himself thereby castrated, lower in self-esteem, emasculated. He generally has few outlets for, or legitimate expressions of, his feminine-submitting, or oblative impulses. *But*, it seems to be somewhat more possible for him to satisfy these tendencies without threat to his picture of himself as masculine, if he can surrender to a God, to some omnipotent, omniscient figure, where rivalry is out of the question. Kneeling before a God is less an unmanly act than kneeling before a rival or competitor or peer. It is "suitable" in the Gestalt psychological sense, appropriate, "fittin' and proper," called for; it is not a defeat.

And of course this satisfying oblation is also possible before a human if that person is seen as Godlike enough, "great" enough; *e.g.*, Napoleon, Hitler on the one hand, Lincoln, Schweitzer on the other.

It is also interesting to observe that most women in most cultures that we know are apt to be more religious (in this sense) than their men are. They seem to be less threatened by oblation, and to be more able to enjoy it in an uncomplicated way. So also are women apt to be less destroyed and less rebellious, made less "neurotic," by conquest of their society from without. Their admiration for the conqueror is less threatening to their integrity as persons than it is in men who must fight against their oblative tendencies or else lose self-respect. Or to put it in another way, being raped (in whatever sense) is less psychologically damaging to women than to men. Women are more able to permit themselves to "relax and enjoy it" than men are.

HEALTHY DIFFERENTIATION OF DOMINANCE FROM SEXUALITY: DESEXUALIZATION

One hoped-for effect of depth therapy is to separate and un-confound these two areas of life, and to keep them differentiated, to learn that the penis is in fact not a club or a sword or a rending instrument, that the vagina is not a garbage pail or a biting mouth or an engulfing well; that the above or below position in the sexual act is meaningful only for sexual convenience and pleasure; that taking orders from a superior is not equivalent to being raped; that stronger people need not be made a sexual oblation to in order to avert their anger. It is hoped for the woman that her sexual surrender becomes *not* a giving up of her ego or self-respect; it is *not* a conquest in which by surrendering she concedes her slavish status thereafter. The male must learn that by penetrating his wife, he has neither conquered nor asserted mastery nor committed a sadistic act. Nor has she thereby conceded submission in other areas of life. Nor need he feel guilty or fearful after the sexual act if he can feel that he is welcomed rather than resented, if he has not conquered but collaborated. And so on.

What all this amounts to is the differentiation of sex from dominance and subordination. It seems likely that this is really, *fully* possible only for the human being, although there seem to be some approaches to this separation in the chimpanzee.

A paper (8) whose theoretical implications have been overlooked, called attention to the qualitative differences in what was called "dominance-quality" in the three large families of infra-human primates. Briefly, all the New World monkeys show a laissez-faire quality of dominance. All the

Old World monkeys and baboons show the kind of sado-masochistic or dominating, tyrannical quality of dominance we have mostly talked about in this paper. The anthropoid apes (of whom we really know only the chimpanzees) show a more friendly, altruistic, cooperative quality of dominance. We do not have enough data, even on the chimpanzee, to be very confident of this. But what we *do* have indicates that there is absolutely less pseudo-sexual behavior, less dominance-sexual equivalence, less dominance mounting, and the like. Certainly there is less bullying, cringing and cowering.

This suggests (nothing more, of course) that the dominance-sexual fusion is a lower evolutionary development than the differentiation of sex from dominance and parallels our suspicion that such a differentiation in the human being may be a correlate or epiphenomenon of greater psychological maturity or development. Considering the importance of such a speculation, it certainly calls for more investigation than it has received.

The obverse implication is that the confounding of sex and dominance in the human being may be an evidence of immaturity or of neurosis, of the loss of a distinctively human capacity, of mild psychopathology, of human diminution.

HEALTHY FEMININITY AND MASCULINITY

Of course, there are many theoretical possibilities here, and all fascinating. We mention one only because we have data that bear on this puzzle. It *may* turn out that healthy growth or psychotherapy in the human being has as its hoped-for consequence *not the abolition* of the dominance-subordination relationships as between male or female at their deepest levels, or between parents and children. What may rather be the case is a change in what has been called "dominance-quality" from the baboon quality to the chimpanzee quality. In chimpanzees, the dominance-subordination syndrome can also be seen but it has taken on an entirely different flavor, one of kind and fostering and responsible strength which is at the service of the weak; older-brotherly dominance it was called. By this time the words "dominance" and "subordination" become misnomers and can be very misleading. Substitutes might be, for instance, "kind and loving strength" and "trusting dependence."

In any case in the human being, the healthward shift is away from devaluation of the subordinate status with mutual hostility, toward an accepting and loving attitude. Concomitant with this is a desexualizing of the statuses of strength and weakness, and of leadership so that either man or woman can be, without anxiety and without degradation, either weak or strong, as the situation demands. Either must be capable of both leadership or surrender; *e.g.*, a therapist has to be motherly, unfortunate mothers must be ready also to father their children.

We have in essence been concerned with the old problem of bisexuality, of the conflict between "maleness" and "femaleness" in either male or female, penis envy, castration anxieties, masculine protest and phallic masculinity.

Without trying at this point to spell out consequences in detail, we may point to the following pregnant fact. There is evidence available to indicate that the sexual hormones produce not only sexual but also dominance desires. That is to say, the same hormones may produce both the sexual syndrome and the dominance-subordination syndrome. No wonder they are so intimately interconnected. Indeed, the problem then is transformed into understanding how they become separated, independent; *e.g.*, how position in the sexual act becomes detached from dominance-subordination meaning, how the penis can become *only* a sexual tool and not a power weapon, how the anus can become only a defecating organ and no more a sexual receptacle, how an employee can come to take necessary orders without feeling feminized-subordinated.

POSTSCRIPT

For those of you who enjoy the game of theoretical speculation and manipulation, there is much here to play with. For instance, with respect to Freudian theory, we have opened up the possibility of combining oedipal theory and castration theory in a single and unified system. They can both be pushed into the more general phrasing of "the mutual accommodations of the strong and the weak to each other and the pathological sexualization of these accommodations." We have opened up another possibility with respect to Freudian and Adlerian theory, namely, that they may be, in the respects we have dealt with, isomorphic parallel languages, at an archaic level saying the same thing, one from the sexual side of the fusion, the other from the dominance side of the same fusion. The so far mysterious problem of the definition of healthy masculinity and feminity have been touched on, and this is clearly *one* way of playing with this mystery. We have only barely mentioned the thread of sexualization that can be plucked out of the web of inter-class and caste relationships. We have bypassed altogether the intricate questions of the relationships of culture to our primate inheritance even though we are quite convinced that the study of infra-human primates has much to teach the sociologist. We imply another approach to the psychoanalytic theory of instincts and still another, toward the understanding of sadism-masochism, of authoritarianism, of hypnosis, of the need for achievement, of the definition of the various types of love, of religious oblation, even of the servant problem. And so on, and so on.

REFERENCES

1. KEMPF, E. J. The social and sexual behavior of infra-human primates. Psychoanal. Rev. **4:** 127–154, 1917.
2. MASLOW, A. H. The authoritarian character structure. J. Soc. Psychol., **18:** 401–411, 1943.
3. MASLOW, A. H. The comparative approach to social behavior. Soc. Forces, **15:** 487–490, 1937.
4. MASLOW, A. H. The determination of hierarchy in pairs and in a group. J. Genet. Psychol., **49:** 161–190, 1936.
5. MASLOW, A. H. The dominance drive as a determiner of the social and sexual behavior of infra-human primates. I. Observations at Vilas Park Zoo. J. Genet. Psychol., **48:** 261–277, 1936.
6. MASLOW, A. H. Dominance-feeling, behavior and status. Psychol. Rev., **44:** 404–420, 1937.
7. MASLOW, A. H. Dominance-feeling, personality and social behavior in women. J. Soc. Psychol., **10:** 3–39, 1939.
8. MASLOW, A. H. Dominance-quality and social behavior in infra-human primates. J. Soc. Psychol., **11:** 313–324, 1940.
9. MASLOW, A. H. Individual psychology and the social behavior of monkeys and apes. Int. J. Individ. Psychol., **1:** 47–59, 1935.
10. MASLOW, A. H. *Motivation and Personality*. Harper, New York, 1954.
11. MASLOW, A. H. Power relationships and patterns of personal development. In *Problems of Power in American Democracy*, Kornhauer A., ed. Wayne Univ. Press, Detroit, Mich., 1957.
12. MASLOW, A. H. Self-esteem (dominance-feeling) and sexuality in women. J. Soc. Psychol. **16:** 259–294, 1942.
13. MASLOW, A. H. *The Social Personality Inventory: A Test for Self-Esteem in Women* (with manual). Stanford Univ. Press, Stanford, Calif., 1942.
14. MASLOW, A. H. A test for dominance-feeling (self-esteem) in women. J. Soc. Psychol., **12:** 255–270, 1940.
15. MASLOW, A. H. A theory of sexual behavior in infra-human primates. J. Genet. Psychol., **48:** 310–338, 1936.
16. MASLOW, A. H. AND FLANZBAUM, S. The experimental determination of the dominance behavior syndrome. J. Genet. Psychol., **48:** 278–309, 1936.

RECENT SOVIET WORK ON REACTIONS OF THE CENTRAL NERVOUS SYSTEM TO IONIZING RADIATION

WALTER R. STAHL, M.D.[1]

INTRODUCTION

A number of Soviet radiobiologists maintain that the nervous system is very sensitive to radiation. They also state that many types of pathological reactions resulting from irradiation are caused by nervous system mechanisms. This view is not accepted by the large majority of Western radiation researchers (and some other Soviet scientists). A continuing close examination of literature on this subject in the Russian language is, accordingly, of special interest. The present article is the second survey of Russian work on nervous system effects of radiation completed by this writer and covers materials published mainly in 1958–1960; the first review (52) should be consulted by those wishing a complete documentation.

About nine-tenths of the references covered in this article remain untranslated and were read in the original. Most of them, however, are easily obtained from the National Library of Medicine as photostats and thus accessible to persons with a reading knowledge of Russian. Many Soviet journals can now be obtained by direct subscription and therefore it has been possible to review materials published quite recently.

Additional information for the review was obtained during the 1959 US-USSR Radiobiology Exchange Mission, in which the reviewer was privileged to take part. This Exchange involved a month in the Soviet Union and visits to many laboratories where work on nervous system effects is in progress. Pertinent information obtained during the trip has been included in the review, either explicitly or by way of interpretation of articles in the literature.

Several important sources of information on Russian radiobiology are available to persons without a knowledge of Russian. The reports presented at the major 1955 and 1958 Geneva Conferences on the Peaceful Uses of Atomic Energy include several review articles on nervous system effects. These surveys, while certainly interesting, are generally too concise to allow an adequate understanding of experimental techniques and findings. The U.S. Atomic Energy Commission, National Institutes of Health, and other federal agencies, have active translation programs which cover all aspects of Soviet science. Several important translated books will be mentioned below.

The serious student of any aspect of Russian physiology or psychology is urged to read Pavlov in the original. An excellent translation of his classical volume, *Conditioned Reflexes*, is now available at modest cost (44). It appears that Pavlovian theory is not understood fully by a great many Western biological scientists and a careful study of Pavlov's own writings may be extremely rewarding. Such an undertaking also helps to clear up a great many points causing possible confusion in the experimental materials to be described below.

Because of space limitations the writer has tried to make each review as brief as possible, consistent, however, with an effort to present the basic outlook of the original author in every case. Some distortion is probably unavoidable when reducing a long article to a one-paragraph summary: for this the reviewer must apologize.

[1] School of Science, Oregon State College, Corvallis, Oregon, and Radiology Department, University of Oregon Medical School, Portland, Oregon. This work was supported by Traineeship BT-555 of the Institute of Neurological Diseases and Blindness, of NIH, and research grant T-14 of the Division of Research Grants, NIH. The help of these organizations is gratefully acknowledged.

PATHOANATOMICAL CHANGES AFTER RADIATION

Societ work on histological changes in the central nervous system (CNS) after radiation, reviewed previously, revealed that two schools of thought existed in the USSR on morphological sensitivity of the CNS. Some workers found it to be structurally rather radioresistant and observed few changes below about 1500 r (roentgens). However, certain other researchers, *e.g.* Aleksandrovskaya, felt that they could discern significant alterations at levels as low as 50 r.

In addition to a continuing publication of reports supporting both viewpoints, there have also been a number of recent articles concerned with pathoanatomical changes in nerves of radio-sensitive organs, such as the spleen. Work dealing with alterations in the brain proper will first be reported.

I. A. Brodskaya and I. P. Merkulova (12) gave dogs 5400–12,200 r to the brain in divided doses. The first pathology was found histologically after about 5400 r but was not marked. At levels above 10,000 r there was obvious damage. These authors feel that both direct neuronal and indirect vascular mechanisms were responsible. In an investigation of brain damage from therapeutic radio-gold colloid administration T. M. Vikhert *et al.* (55) accepts the usual view that several thousand r local tissue dose is needed for significant brain damage.

In a general discussion of CNS effects, A. V. Lebedinsky (29) states that changes in the midbrain and hypothalamus, reticular substance and some autonomic ganglia are found after doses in the mammalian semi-lethal range. This leading Soviet radiobiologist also discusses the entire matter of CNS sensitivity in one of his 1958 Geneva Conference papers (30).

M. M. Aleksandrovskaya (2) has reiterated her former position that the CNS is very radiosensitive pathoanatomically. Rats were given successive doses of 50 r, (all doses refer to whole body exposure, except as noted) with totals to 350 r, and their brains studied by special staining methods. It is said that silver and nucleic acid stains revealed pathology after the first 50 r, in the form of darker granules in some neuronal cells. Following doses of 150 r or higher changes were pronounced, with neuronal cytolysis, vacuolization, hypertrophy and cell breakdown in a considerable number of cells. Glial alterations were also seen above 100 r. The percentage of neuronal cells revealing such effects is not analyzed numerically.

Work intended to show damage specifically to synapses has been reported by I. D. Lev (32). Rats were given 450–600 r and their spinal cords examined at 5–12 days after radiation. Abnormalities were found in form of hypertrophy (rings), vacuolization, and unusual nodules (buttons) in synapses. These changes are not reported as being specific for radiation and in fact are thought to represent some sort of adaptive response to the associated radiation sickness. The frequency of such abnormalities is not stated.

Several papers have dealt with general peripheral nerve damage after whole body radiation. For instance, V. V. Anisimova-Aleksandrova (4) gave doses of 400 to 1500 r to various laboratory mammals and studied various nerves at 2–3 days after radiation, by which time some of the animals had died. Alterations are reported to be inconstant in different types of structures. They were marked in some afferent sensory nerves but minimal in sympathetic and proprioceptive fibers. The dura mater and eye muscles were given special attention in this work. Results are difficult to interpret because of the non-uniform reactions and possibility of tissue autolysis in some cases.

In another general study Gromada (24) sacrificed rats three hours to three days after giving them 2400 r. The auricle of the heart, intestinal plexei and the bursa of the knee were studied in detail. The findings at four hours were equivocal, but at 24 and particularly at 72 hours, clear neuronal in-

jury was apparent in the form of increased argyrophilia, varicosities, and cyst formation in receptors. However, this investigator points out that there is considerable normal variability in the cited structures and that even with these large doses the changes were not very striking. He also notes prior Russian works by Otelin and Kupriyanov in which periosteal nerves and cardiac receptors were found to be radioresistant.

An overall study of changes in skin nerve structures is discussed by N. N. Garvey (20). He gave rats 700 r and sacrificed them 1–11 days later. At times as early as 1–3 days after exposure changes such as increased silver staining and coiling were seen in many nerve fibers; they became more marked during subsequent days. These changes were said to be non-specific but are reported to appear before any other discernible radiation pathology. Epilation is also considered to be a neuro-trophic response.

T. N. Oleynikova (43) investigated nervous system pathology in rats given 600–900 r, or substantial quantities of P-32, and sacrificed 1–12 months later. Degenerative changes were reported in nerve cell bodies and fibers of the skin, intestines, spinal ganglia and elsewhere. Findings include thickening, varicosities, vacuolization and cell breakdown. It is noted that some nerve structures remain perfectly normal.

Four papers report studies that have considered alterations in the receptor endings in specific organs such as the spleen, intestine and large blood vessels. Because of the postulated CNS intervention in radiation pathophysiology, histological alterations in nerve receptors are of particular interest. Alekseyeva (3) gave cats 600 r and killed them on the third day after exposure. Alterations such as coarsening, darkening, and actual fragementation were seen in vascular wall receptors. The consistency or frequency of such pathology is not detailed. Schastlivtseva (49), also working with cats, applied x-ray doses of 750–1500 r or gave equivalent exposures from I-131 and P-32. Nerves and nerve endings in the spleen were studied several days after radiation. Neuronal injury occurred only after the largest doses used in this study and consisted of alterations in preganglionic parasympathetic fibers and receptors; other types of fibers were more radioresistant. The changes found appeared to be slight.

Lastly, two studies—yielding differing results—were conducted on nerves in the gastro-intestinal tract. Zayrat'yants (58) exposed white rats to chronic gamma radiation at one or two r a day for variable periods, after which the animals were sacrificed. Changes are said to occur in intestinal nerve nets after only 60–90 r and represented the earliest radiation histo-pathology. Alterations included coarsening and increased staining of fibers and vacuolization of cell bodies. In a somewhat older work Levinson (33) evidently had to go up to doses of 5000 r to find significant changes in mice which were killed a few hours to three days after exposure. Nucleic acids and phosphates were studied histochemically, revealing changes in nerve cell bodies. The deviations seen were not stressed as being particularly revealing or very early in appearance.

Thus the situation in regard to pathoanatomical changes remains much as before in the Soviet literature. There is a wide divergence of opinion on whether important histological changes can be seen in nervous structures after doses on the order of 50 to a few hundred r. It is perfectly clear that the final studies on this matter will have to control matters such as tissue autolysis and also must specify the frequency with which the cited alterations occur.

EFFECTS OF RADIATION ON SIMPLE MOTOR REFLEXES

No new articles have been encountered recently on this particular type of experi-

mental procedure. For the sake of completeness a brief outline of some works reviewed previously will be provided; the former summary by this writer should be consulted for more details (52).

Experiments by S. A. Livshits in 1947 failed to reveal alterations in stimulation response curves of nerve and muscle preparations from frogs given 4500 r; rather small changes appeared after 6000 r. Ul'yanova irradiated dogs by giving them substantial quantities of Br-82 (0.17–0.34 mc given 1–4 times) and reported alterations in timing of the hip withdrawal reflex. Gvozdikova irradiated rabbits with 500–1000 r to local sites, the spine or entire body. Unconditioned motor reflexes are said to have been depressed after exposure in most cases.

Kudritsky and his associates published a number of articles on the knee withdrawal reflex in the rabbit. Implanted subcutaneous electrodes were used for stimulation. Using daily exposures of 10 r, a slowing of reflex response time by 2–10 times is said to have appeared in about 25 days (250 r). However, this alteration later disappeared in spite of continuing exposure, a reaction which Kudritsky interprets as an adaptation to radiation.

His later work also purported to reveal possible adaptation. Doses of tens or hundreds of r were given prior to a standard test dose of 10 r. Timing of the knee reflex was the main experimental parameter. The major post-radiation effect seen was an increase in the *variability* of the latent period, but not its average duration. Pretreatment was said to reduce the deleterious action of the 10 r test doses.

Considering the relative ease of experiments on simple reflex systems and their susceptibility to precise quantitative analysis, it is a little surprising that they have been given so much less attention in recent Soviet work than the much more complex conditioned reflexes.

EFFECTS OF RADIATION ON CONDITIONED REFLEXES

The mainstay of Soviet experimental physiology, conditioned reflex (CR) experiments, continue to be used widely in studies of radiation effects on the CNS. It should be stressed that Russian researchers use "conditioned reflex" in a broad sense, to describe practically any kind of chronic physiological study that involves some identifiable stimuli; often, of course, classical Pavlovian conditioning methods are used. It continues to be asserted that changes in CR's are one of the earliest indicators of radiation damage to the organism and may sometimes occur at dose levels which even fall below the current occupational exposure levels.

It appears that the lowest thresholds for CR changes have been reported by the Institute of Higher Nervous Activity of the Academy of Sciences of the USSR, where radiobiological work is headed by I. A. Piontkovsky (45). Reviews by Piontkovsky and Ivanitsky (46) assert that lasting changes may occur in motor CR's after 0.5 to 15 r. It is said that a single exposure in this range often has a stimulating effect which continues for weeks. Ivanitsky speculates that the stimulation results from afferent overactivity which activates the hypothalamus in some manner. The exact experimental procedures used in these trials have not yet been found in the literature.

L. Ye. Khozak, who also works with Piontkovsky, analyzes in detail the effects of seven successive doses of 50 r given to a group of 11 white rats with previously developed CR response patterns (stereotypes) (26). Spacing of the doses was varied from one to several weeks. It is stated that a general stimulatory effect was observed on CR's after the first three doses, with some fine variations following each 50 r exposure. Such effects on CR's sometimes appeared in as little as 15–20 minutes after irradiation. Exposure beyond a total dose of 150 r resulted

in a weakening of CR's, increased errors of performance and evidence of disturbed cortical balance. Recovery took place over a period of several months, during which time reactions were irregular ("phasic" period). The reflexes used were of a motor-feeding type and were analyzed by measuring the force and length of time an animal would press a bar or lever to get food.

This reviewer analyzed the data from the latter study statistically. If one includes all data on strength, latent period, etc., from the control trials and through completion of 350 r total dose, the variance of individual trials does not exceed those expected at the .05 level. However, the author might not agree with this procedure: he would consider inter-trial results as more significant, possibly, than the overall effect. It is clear that for such a case much larger numbers of animals will have to be used to obtain statistically significant findings.

This situation is further complicated by the fact that most Soviet physiologists take note of the Pavlovian CNS type of their animals. This fact has been particularly stressed by Kotlyarevsky, also at the above Institute (28). He points out that CNS typing needs to be done on all experimental animals; it is based on Pavlovian methods showing the relative strength, balance and mobility of cortical excitation and inhibition. Three basic CNS types are usually identified: strong-balanced, strong-unbalanced and weak or inhibitory. It is said that in strong-balanced animals (rats, as above) 50–100 r causes only a modest initial increase in cortical excitation; larger doses, up to 350 r, result in depression. Animals of the strong-unbalanced type respond to radiation with more general agitation and show evidence of poor inhibitory control. Animals falling into the weak CNS classification reveal an earlier loss of CR intensity and recover more slowly. This additional degree of freedom in analyzing experimental results certainly makes interpretation even more problematical.

It should be pointed out that the above approach is in keeping with the classical Pavlovian method in which a small number of animals are subjected to a great many standardized trials (1000–1500 for 10 animals, commonly), and the observer's evaluation of effect is taken as being valid without statistical analysis. The reviewer had an opportunity to see the techniques used directly during the 1959 Radiobiology Exchange Mission and has discussed them with many of the cited researchers. Clearly great experience and skill are involved in their successful execution. However, it can be said that while direct observation of the same animal for hundreds of trials may certainly lead to a strong conviction of effect, this does not eliminate the need for application of usual criteria from the theory of probability, which, in fact, has reached a high state of theoretical perfection in the USSR.

Other types of work known to be in progress at the above Institute include CNS studies of relative biological efficiency (RBE) of various radiations; studies on various species of animals; other types of CR experiments; EEG studies; histochemical and tracer studies on the CNS. As will be noted below, this laboratory also has published extensive materials on CNS effects following antenatal radiation exposure.

Additional work on CR-radiation effects has been carried out at other research centers. Samoylova (48) reports a CR study on eight control and ten experimental rats with well-developed motor-feeding CR's. The radiation dose used was 0.1 r every other day. It is reported that after as little as 1.2 r cumulative exposure, certain rats showed altered strength of reflexes, made more errors and demonstrated other changes. After 5 r such effects were increased; a return to normal did not occur until about one year after cessation of exposure. No other evidence of injury was seen. A statistical analysis or tabulation of data is not included.

Yarullin (56) reports on experiments

based on a protective CR against electric shock to the paw that was developed in three dogs. Animals were exposed to doses of 15 r daily, with total doses of over 1300 r. It is concluded that some changes, such as an increase in latent period, may appear after even a single 15 r dose, but that the CNS compensates well; two animals showed nearly normal responses even after 1300 r. Allowances for CNS type of the dog were made when interpreting results. The data presented indicate only small alterations, whose statistical significance is not certain.

In still another low-level study, seven mice were subjected to 1300 conditioning trials by Malyukova (37). Electric shocks from multiple metallic floor strips were used as unconditioned stimuli. The animals could avoid a shock by moving to a different section of a chamber over a low wall, in response to light or sound signal. A reflex pattern was developed and then allowed to extinguish spontaneously once. After being reinforced again eighteen 10 r doses were given over a period of eight weeks. Extinction tests were then conducted again, in a manner not detailed too fully. It is said that in general extinction occurred about twice as fast after the full 180 r, but that even 10–20 r had a discernible effect on CR's (stimulatory) and on their extinction (due to changes in internal inhibition). In this experiment the first extinction trial served as the control, which is not satisfactory because subsequent extinctions are expected not to be identical in their course. Experiments with extinction may be a very sensitive type of indicator for CNS effects but are difficult and will require very strenuous control measures.

In regard to CR studies at radiation levels somewhat higher than those quoted above, one may first consider the work of Belonsky (7). Rats were conditioned to various sound stimuli using painful electrical stimulation of a paw. Radiation exposures of up to 4000 r were used and the effects of several radiochemical protective agents on CNS responses also investigated. It is said that 350–700 r whole body exposure had a stimulating action on CR's while doses above this level usually caused marked depression of response. Chemical protectors such as aminoethylisothiuronium (AET) or mercaptobenzthiazol are said to decrease the CNS effect at a dose level of 700 r. No statistical analysis of the results is given, and the tracings shown are very difficult to interpret.

It may be noted at this point that work reviewed previously also stressed CR effects at dose levels of several hundred r (52). Livshits reports on two dogs with digestive CR's which were given 25 r daily for some weeks. After a total of 600 r the responses were seriously deranged. One might think of direct salivary or gastric action in this case, but Livshits claims that conditioned responses were more disturbed than unconditioned ones. However, with digestive or feeding experiments of any type direct somatic damage to the effector organ will certainly have to be ruled out.

Working with pregnant animals, Baskakov (6) developed a conditioning pattern to light and sound in gravid and control rats. It was found that with pregnant animals a single dose of 250 r altered the behavior of the animals in a few days, in that they became sluggish and depressed, making more errors in the trials. In nonpregnant animals a similar reaction appeared later; at 1–2 weeks. It is stressed that CR methods disclosed behavioral changes which were not evident from simple observation and that pregnant animals (and also the suckling young) are more sensitive to irradiation.

Working in about the same dose range, Meschersky (40) studied the effects of direct local cortical irradiation in the rabbit on established CR's to electrical shock of the paw. A light was used as the stimulus and the visual receptor area of the cortex irradiated through a skull opening. Single exposures of 25–200 r of gamma or x-rays appeared to have a specific and repeatable effect: there was an increase in strength and accuracy of the conditioned response, pos-

ibly improved differentiation (between right and dim light), and an increase of latency and of random motor activity between stimulations. The author feels that a direct stimulation of the cortex was responsible for the changes. The presented data allow of no statistical analysis of this interesting result.

In a paper on the long-term effects of isotope administration, Biryukina (8) reports on CR's in dogs getting 0.02–0.1 μc/kg of Sr-90 per day for long periods of time. The results are somewhat surprising in that animals on the higher dose schedule of 0.1 μc/kg per day did not reveal any change in CR's until three months following cessation of administration, while dogs receiving 0.02 μc/kg per day apparently demonstrated a considerable increase in salivation after only three months of intake. In both cases the accuracy of differentiation in a CR test pattern remained unchanged. It is reported that test agents such as caffein and bromides will produce abnormal effects in animals getting 1 μc/kg daily of Sr-90 for six months or longer.

By no means all Soviet physiologists have found the CNS to be very radio-sensitive. In fact, as was pointed out in the previous review of the subject (52), M. I. Nemenov, who worked directly with Pavlov, was evidently not much impressed by the changes in a dog getting 1500 r to the head. In later work Nemenov and his collaborators felt they could show alterations in finer details of performance after about 1000 r given to the brain. Interestingly, Nemenov noted an improvement in performance which could be attributed to less distractibility on the part of the animals, a finding since confirmed in a number of Western studies.

Other previously reviewed papers assert that 750–4000 r cumulative exposure has a marked effect on digestive CR's, but may not influence motor reflexes. Animals given 300–750 r to the body and tested by classical Pavlovian salivary gland studies appeared to show some stimulation of conditioned response for 1–4 days after radiation, with a subsequent decline. However, this change was paralleled by similar alterations in the unconditioned salivary flow after acid stimulation and thus interpreted as being of somatic rather than cortical origin. The same author also gave doses 0.18 to 2.6 mc of Co-60 intravenously and found minimal alterations of cortical activity, as shown by classical Pavlovian methods.

In a later discussion of the whole CNS radiosensitivity situation, Lomonos (36) notes differences of opinion as to CNS radiosensitivity. According to this author's latest work only rather small changes could be demonstrated in conditioned vomiting responses in dogs given 400 r.

In a paper on electroencephalographic changes, to be reviewed below, Korol'kova (27) comments that the normal formation of new CR's was not hindered by 2200 r; there was no lasting cerebral inhibitory action with this dose and the effects of radiation on experimental neuroses in animals were not striking.

Thus there is clearly some difference of opinion among Soviet scientists concerning the radiosensitivity of the CNS. Reviewing the whole situation, M. N. Livanov states again that many researchers have found CR effects following doses 3–25 r. The most sensitive type of change is said to be loss of fine internal inhibitory control, leading to more random and uncontrolled responses. Livanov stresses that other biological systems have been shown to respond to doses as low as 2–5 r. He also remarks that quite a few studies have been done on occupationally exposed humans, using verbal CR methods. Irradiated subjects are said to perform less well than non-irradiated ones. Livanov feels that effects probably occur even below the cited levels, but are not detectable because of CNS compensation or adaptation.

A CR study somewhat different in intent from the above has been reported by Gorbunova (22). In this experiment radiation was given to a small area of skin or exposed

gut mucosa (using an animal with a chronic fistula) which served as a stimulation site for CR's. It is reported that doses as low as 2 rad of P-32 betas to the local area caused a prompt increase in CR response (salivation) which lasted for a few hours to two days; later there was a depression due to "protective inhibition" involving the hypersensitive local receptor area. Even CR's from other skin sites may be affected if the radiated area is tested before using the other stimulation locations, because of the abnormal reactivity of the latter.

Lastly, mention should be made of some interesting work not using CR methods but dealing with general effects of radiation on higher nervous activity. D. A. Biryukov has published data dealing with the effects of fairly small doses of radiation on catalepsy in chickens, which was induced by placing them in a box with flashing light (9). It was found that 100 r to the head of a chicken caused it to emerge from the cataleptic condition, in a state of agitation, within an hour after exposure. Loud sounds and other strong stimulation did not have this effect as long as the animal was in the box. Subsequent additional irradiations also interrupted the catalepsy but with decreasing effectiveness. Irradiation of other parts of the body did not result in awakening. Biryukov stresses the importance of cortical inhibition after radiation, though in this instance cannot conclude whether the effect was basically inhibitory or excitatory.

In his 1958 Geneva article, Biryukov (35) also observes that 3600–5000 r will not significantly alter ordinary positive CR's in chickens. Pigeons are similarly resistant to doses of up to 2500 r; however, hens will come out of a cataleptic state with much lower doses. Pigeons may show postural disturbances after radiation in the absence of CR changes. The author feels this shows that in fowls subcortical brain centers are much more affected by radiation than the cortex. Chlorpromazine is stated to act on subcortical structures and was found to interrupt catalepsy in the same way as radiation. An additional conclusion, reached logically from the above, is that CR methods are not always the most sensitive way of demonstrating CNS radiation effects.

ELECTROPHYSIOLOGICAL STUDIES ON RADIATION EFFECTS

M. N. Livanov, at the Institute of Biophysics of the Academy of Medical Sciences of the USSR, has been the most outspoken protagonist of the view that the bio-electrical studies reveal alterations after small doses of radiation. He has supervised work which is said to demonstrate an effect on the EEG after one r or less and will be presented below. A paper recently became available in translation which provides his full description of the events in the CNS following exposures to near-lethal doses in rabbits (34). Five animals with implanted cerebral electrodes were used and irradiated with 800–1000 r of x-rays to the whole body. Livanov says that this dose results in strong abnormal afferent inflow to the CNS and perhaps some additional direct neuronal damage. The result is an initial central inhibition of spinal reflexes, resulting from gradually rising subcortical (hypothalamic) and cortical excitement. After a few days the subcortical excitement continues to increase but a reactive inhibitory depression of the cortex is observed. Death during acute radiation sickness is said to occur because of failure of brain stem regulatory nuclei, particularly the respiratory center. The very complex set of reactions outlined by Livanov is based largely on the hypothesis that there is an important continuing afferent flow of nerve impulses, resulting from radiation damage, which initiates other pathophysiological responses. In animals getting lower doses or surviving the above doses there is a recovery phase with irregular CNS reactivity.

In his 1958 Geneva paper (35) Livanov provides considerable factual material in support of his theories, outlined above. This

etailed review article is difficult to summarize briefly and should be consulted by he interested reader. Most of the experimental data reported in it deals with effects f 800–1000 r given to the cat or rabbit. A ew of the findings will be noted.

Increased afferent activity following radiation is demonstrated in the celiac nerve f the cat (at one and three days) and in the agus nerve of the rabbit (at 20–100 min.). The muscular response of a knee flexor reflex in the rabbit is found to be depressed after exposure. EEG's show an early excitement at 30 min, but later depression at two hours and 24 hours. Activity in the optic nerve in response to flashing light is reported as being variable. Hypothalamic thresholds for an EEG reaction appear altered early after exposure and at the terminal stage of radiation illness. The muscular response to vertical rotation of a rabbit in space is changed for 1–3 days after irradiation. In general the EEG and some CR's in rabbits are depressed for 1–3 days following 500 r. EEG reactions to rectal balloon inflation is abnormal after radiation.

A. V. Lebedinsky, who heads the Institute in which Livanov works, also comments on bioelectric effects in his important Geneva review "Effects of Small Doses of Radiation" (30). Materials are presented on the technique of measuring cortical reactivity thresholds, as shown in the EEG, by using a controlled, slowly-rising level of visual stimulation in the rabbit. The presented data indicate that during actual delivery of a dose of about 1–7 r, given in a few seconds, the cortical threshold for a response to light is decreased. However, only 30 seconds after completion of an 8 r exposure this parameter appears normal once again.

Lebedinsky also presents considerable material on the radiosensitivity of frog retina to radiation. It appears clear that 10 r alters a standard "electroretinogram" significantly, with the usual finding being an initial stimulation. However, low concentrations of P-32, delivering only 0.15 rad/day, cause an apparent rapid decline in frog retinal activity. The question of whether subliminal retinal stimulation may occur because of radiation is very important, because such activity might be involved in some cortical reactions. The above author points out that a photochemical system is expected to be sensitive to radiation and a response on its part need not represent a pathological lesion.

Working in Livanov's laboratory, Tsypin (54) recently reported on the results of trials with some 200 rabbits from which EEG's were taken during exposure to gamma rays from a Co-60 irradiator unit, using dose rates of about 1 to 450 r per minute. Recordings were made from the skull, with pin electrodes and an indifferent skin electrode. Middle ear structures were destroyed in most animals to prevent auditory clues associated with positioning of Co-60. The typical response found in this study was a brief change in EEG wave form, in the form of a rather small spike or burst of higher voltage activity, which was not precisely defined by the authors. Such a response is said to occur within seconds after application of a radiation field with an intensity of 150 r a minute or higher. At levels of 20–60 r per minute the response frequently appears during early seconds of exposure but may also be delayed and appear sometime later during the standard five-minute exposure period. At dose rates of less than 20 r per minute and down to one r per minute, the response in question may occur during the five minute period or may be entirely lacking. During control experiments, for which iron was substituted for the Co-60 in the irradiator, it is said that no such characteristic waveform alterations were seen. Taking the time of exposure and dose rate factors together it appears that a response occurs in most cases after absorption of about 10–15 r. The main difficulty with this experiment is a lack of precise definition of the EEG alteration. Presented records do not reveal a clearcut spike or other effect which one can measure

readily. There is also some question as to control for vibration and movement; the EEG effect might be a weak startle response. The experimental procedure used here was observed by the US-USSR Radiobiology Exchange Mission and unfortunately no response occurred in a demonstration experiment even with a dose rate of 450 r per minute. However, a failure with guest observers present might be expected. It is also worth noting that in the above no effect on the EEG beyond the transient "startle type" reaction is claimed, a result which seems to mitigate against the view of an alteration in afferent inflow which lasts for several days.

Yu. G. Grigor'yev, who also works with Livanov, recently wrote an entire book devoted to EEG effects in persons undergoing radiation therapy of the brain or other parts of the body (23). It is difficult to summarize this author's many findings and theoretical positions briefly, but the following gives some idea of his viewpoint. The work was done with doses in the range of 50–200 r given repeatedly to a small brain field, using cumulative exposures of about 2000–5000 r, as is customary in tumor therapy. EEG tracings were the main parameter investigated, sometimes with addition of special stimuli such as a flashing light or caffein. It was concluded that the EEG shows an excitement reaction at about 30–120 minutes after exposure. The reaction occurs when either the brain or other parts of the body are exposed and is explained on the basis of abnormal afferent inflow. With subsequent therapy sessions this stimulatory effect diminishes, suggesting a cortical adaptation. Folowing several brain irradiations there is a depression of EEG potentials, associated with decreased reactivity to standard stimulants and some evidence of decreased cortical capability as studied by behavioral methods.

The author states that the depression is mostly the result of active cortical inhibition, which results from the abnormal inflow and acts *via* subcortical centers. He notes that some direct damage is also possible. The cited inhibition occurs in an irregular "phasic" manner and may result in appearance of slow vegetative rhythms in the EEG. After radiation of areas other than the brain there is also an EEG response and this is said to be due to increased afferent inflow.

A number of important questions are raised by the work of Grigor'yev and Livanov. In connection with the above reports on patients getting x-ray therapy, one would like to be assured that full control was maintained for patients becoming accustomed to the treatment situation, which might cause initial anxiety and later drowsiness. If a major increase in afferent inflow occurs, is it of adaptive value or random? If an adaptive response is hypothesized, what are the receptors involved and what is the evolutionary basis for such cortical reaction to radiation? Should there not be at least some moderately strong sensation connected with the cited afferent inflow, which is said to be strong enough to cause important disturbances in CNS activity? If active cortical inhibition lasts for weeks or months, what is the cause of the continuing afferent activity? And what is the role of direct neuronal damage in all of the above?

Another technique being used to show CNS radiation effects is the so-called "cortical mosiac" device, also developed by Livanov and seen on the Exchange trip. This is a 100-channel EEG which is used to obtain recordings from 100 points on the skull of a rabbit. Potentials are presented as spots of varying intensity on an oscilloscope face. Various stimuli, such as flashing lights, produce typical alterations in the "mosaic" pattern. Radiation is said to alter the characteristics of the "mosaics" under various conditions. This interesting device was demonstrated but unfortunately time did not allow comparison of radiated and unirradiated animals; the reviewer has not yet seen a detailed report in the literature on the nature of the reactions found.

Working at the Institute of Higher Nervous Activity, Korol'kova (27) gave 21 rabbits 50–2200 r in divided doses and investigated effects on the EEG. Needle electrodes on the skull were utilized. It is said that single exposures in the range of about 5 to 200 r produce a consistent initial stimulation of cortical activity, associated with increased reactivity. Repeated exposures produce less effect and an inhibitory phase with irregular responses usually was seen after 3–4 irradiations. It is rather striking that the cited responses are said not to depend on the size of the initial dose (5–200 r) which suggests unknown factors may be operative. This author feels that EEG changes are more sensitive than alterations in CR experiments, which were said to be rather small even after 2200 r.

N. S. Delitsyna has tried for a number of years to isolate and demonstrate increased afferent activity from local nervous receptors and has reported her findings in several articles (16–18). Work has been done with human therapy patients and experimental animals. Patients getting localized irradiation were tested for EEG response to touching of the skin with a fine brush. It is reported that there is an augmentation of EEG response after local skin radiation, at least during the first few therapy sessions. Controls for this difficult procedure were not numerous. Related work was done on rabbits which were given doses of 500–5000 r to a paw. Recording of regional nerve action potentials and the EEG is said to show increased responses after radiation. In addition, work was done on stimulation of major visceral nerves and pressure stimulation of the rectum, after whole body radiation. In all cases alterations of responses to standard stimuli were noted. It is concluded that the irradiated sites produce abnormal afferent activity. An available translation should be consulted for fuller details on this matter (18).

In another report, Yanson (57) describes CNS alterations after whole-body and partial-body radiation of rabbits with 500 r. Some 636 experiments were done on 13 animals and over 1000 EEG tracings obtained. After head or whole body irradiation CR's are said to decrease within an hour and in some cases to be absent entirely at 24 hours. No particular change seems to have been observed in the EEG shortly after exposure but it is said to be depressed at 24 hours; recovery of normality in the EEG takes place over 3–7 days, but residual instability may last much longer. After irradiation of the body alone there is no apparent change in the EEG or CR reactions but it is claimed that repeated trials reveal that the cortex becomes exhausted more quickly. For example, conditioned leg withdrawal ceases to occur after only a few repetitions. In distinction from Livanov, Yanson does not describe any early EEG responses and doubts that early afferent overactivity is important. He inclines toward a view of mild direct brain damage with the above doses.

Several other works involving electrophysiological methods shall be noted briefly. Ardashnikov (5) studied the effects of radon inhalation on rabbit EEG's. Using the rather high concentration of 15 millicuries of radon per liter of air, he found a depression of the EEG following several hours of exposure, which was said to persist after removal from the radon atmosphere. The tissue dose is not given and interpretation is complicated by the presence of a tracheotomy tube used to introduce the radon mixture. Pshennikova (47) used an isolated frog nerve-muscle preparation to study radiation effects on both nerve impulses and tonic nerve potentials. About 10,000 r were required to produce a modest decline in the action potential. This dose also altered the stimulation threshold in adjacent unexposed nerve regions, suggesting altered tonic potentials. Other reports on irradiation of isolated nerves are to be found in the journal *Biofizika*, which is translated in full.

RADIATION EFFECTS ON THE AUTONOMIC NERVOUS SYSTEM

For some years A. V. Lebedinsky has specialized in studies of this problem; he recently published a major review of research findings having to do with autonomic reactions to radiation exposure (31). Lebedinsky observes that the typical radiation syndrome may involve changes in autonomic functions such as the following: respiration, thermoregulation, blood pressure and electrical activity of the heart, pressor responses, vascular permeability, gas exchange and general metabolism. Workers in his laboratory have shown that radiation exposure alters hypothalamic stimulation thresholds (using implanted electrodes) for certain EEG reactions, vascular effects and sweating. Studies have also been done on selected peripheral autonomic reactions such as contraction of the nictating membrane in the cat.

Commenting on the large number of findings obtained in his experiments, Lebedinsky finds the results to be rather unpredictable and not readily explained by any one autonomic mechanism of a clearly adaptive nature. Among possible hypotheses he lists altered cortical autonomic control, particularly an initial stimulation of some sort, or altered production of adrenaline or similar autonomic agents. Lebedinsky's important Geneva article (30) and also the prior review by the present author (52) should be consulted for more details on this matter.

Two papers by Maslova deal specifically with the matter of changes in concentrations of sympathicomimetic agents after radiation (38, 39). In the first study this investigator found a rise of adrenaline-like materials at six hours after exposure and during the acute stage of radiation sickness in rabbits given 800 r. Shielding of the adrenals had no effect on the reaction. Section of important sympathetic nerves resulted in a disappearance of sympathins in normal animals; radiated animals showed traces of sympathins under the same conditions. No particular explanation could be advanced for this finding. In a second study adrenaline was measured in the blood and anterior chamber of the eye of the rabbit after the same dose. An increase was noted at 5–10 minutes after exposure and also preterminally. In both cases little information is given on controls used to rule out the possibility of stress reactions to handling in the animals shortly after exposure and it is difficult to deduce the specific role that radiation may play in maintenance of circulating sympathins.

Several reports deal with alterations in blood pressure levels or reactions after radiation, a matter which is obviously closely related to the above. Mozzhukin (41) performed an experiment on 136 rabbits exposed to 800 r of gamma rays from Co-60. Tests were done on the blood pressure response to changes in carotid artery or carotid sinus pressure, using either direct control with a catheter or manual occlusion of the artery contained in a skin pouch. The data reveal that carotid hypertensive reaction is decreased at 1–3 days after exposure and during the acute clinical stage of illness. Section of the vagus and other autonomic nerves was carried out to establish the role of central pressor tone. The presented data clearly demonstrate a weakening of pressor responses at two periods after radiation. In general it was concluded that in some animals pressor responses are inhibited centrally after radiation, possibly as a protective mechanism against bleeding. It is not apparent whether a distinct change in central pressor tone could be shown in all the animals. In older work Komarov noted an early decrease of pressor responses to rectal or bladder stimulation in cats after 1200 r.

Recently Tonkhikh (53) also found a tendency to hypotonia after irradiation. It is known that rats show a biphasic blood pressure rise after a painful stimulation, with increases immediately and after 2–6 hours. About a week following exposure to

300 r the second elevation was absent and the animals showed general hypotonia. The result is attributed mainly to adrenal medullary exhaustion; it is not evident if the animals were in a preterminal condition when this failure of reaction to pain was observed.

Four reports deal with effects of irradiation on gastro-intestinal tract physiology. Brodskaya (13) reported on gastric function in five dogs exposed to 280 r. These animals had gastric fistulas which were used to study gastric secretion and emptying time. In order to get a more controllable situation the above parameters were measured after a standard rectal balloon insufflation, serving as an introceptive stimulus to the gut. In general acid production was quite variable but appeared depressed at about 30 days and 50–60 days after irradiation; gastric emptying time (starch bolus) was also slower at 30 days. Control data for this very complex procedure on a small number of animals are given in quite limited quantity.

In older work Dzharak'yan and Fakhrutdinov (52) studied a variety of physiological responses in the exteriorized loops of two dogs which had been exposed to 400 r. Complex alterations in the systemic vascular responses (blood pressure, pulse rate) to injection of cold water, KCl and nicotine, or balloon insufflation were seen during the period of acute radiation sickness; no important changes could be shown during the latent period, which lasted about nine days. Bokotova has also published an article on motility of the small intestine after beta irradiation of the gut mucosa (11).

Lomonos (28) studied vomiting in dogs given 400 r. Conditioned vomiting reflexes to morphine or apomorphine were developed in the animals. However, as is known from classical Pavlovian work, such reflexes extinguish spontaneously in a rather short time. Therefore it was necessary to turn to the course of extinction as a parameter and the author indicates that irradiated animals seem to lose their morphine response more quickly than controls; they also tend to salivate more, possibly as a protective response. No final conclusion on CNS or autonomic response resulting from radiation was possible in this experiment.

Some work reviewed previously by this author (52) may also be mentioned very briefly. It has been shown that large doses of radiation to local autonomic ganglia can alter their functioning and thereby influence the associated physiological systems. Attempts to prevent autonomic reactions with novocaine blocks of the cervical ganglia, or by the use of ganglionic blocking agents parenterally, do not seem to have been successful in preventing the major manifestations of radiation sickness in lab mammals. Demonstrable autonomic effects of brain irradiation at fairly high levels include alterations in electrocardiograms, respiratory activity, temperature and intraocular pressure. Much work has shown that, following irradiation, capillaries respond abnormally to test agents such as epinephrine; capillary damage is no doubt involved in radiation erythemas. The mechanism of this capillary damage is not clear. Prior Soviet conclusions as to the importance of a CNS mediated change in hyaluronidase production do not seem to have been confirmed, though it is known, for example, that narcosis influences radiation erythema.

OTHER FUNCTIONS OF THE CNS IN RADIATION SICKNESS

It is a basic tenet of "Pavlovian nervism" that the CNS and specifically the cerebral cortex exert a controlling influence over all normal and abnormal reactions in the body, including cell growth, differentiation, inflammation, regeneration and repair, production of chemical mediators, etc. Therefore it is understandable that in the Soviet Union CNS mechanisms have been sought to explain such reactions as radiation leucopenia. The overall view in this situation has been presented clearly by such Soviet scientists such as Bykov (14) and Biryukov (10).

The prototype of a cortical control mechanism may be considered to be cardiac regulation. It should be recognized that the heart can continue to function following denervation, as the result of its inherent properties, but the CNS exerts a finer control which reflects environmental needs. However, in the case of a mechanism such as hemopoiesis, the situation is clearly more complex. Chernigovsky recently discussed this matter (15), and concluded that while direct innervation and CNS control may not have been demonstrated for proliferation of the bone marrow, there are proven nervous mechanisms involved in the release (and thereby maturation) of bone marrow cells, production of hemopoietin in the kidney and in some hemolytic responses. Thus it must be understood that when Soviet authors discuss cortico-visceral control they may include any type of humoral receptor or effector mechanisms, including the hypothalamus, pituitary and all other hormone systems. Even with this freedom, Chernigovsky observes that a CNS hemopoietic control center has not yet been demonstrated and the effects of bone denervation on bone marrow are not great.

A typical illustration of research oriented along the above lines is found in a paper by Gaza (21) on introceptor activity from hemopoietic organs in acute radiation sickness. It is pointed out that altered introceptive reactions after radiation have been shown from the carotid sinus, skin, bladder, small intestine, rectum and blood vessels, but that some prior work on spleen introceptors did not reveal any functional nervous changes. These authors studied introceptors in nodes of the small intestine, spleen and bone marrow of a leg in the cat. Chemical stimuli were used and blood pressure changes registered as a response. Some 21 animals were given 250–400 r and tested at 2–25 days after exposure, with corresponding controls. In general the radiated animals are said to show longer latent periods of response, less increase in blood pressure and sometimes more prolonged reactions. It is not clear whether these changes occurred in all animals. The effect was most marked during the acute clinical phase but is sometimes said to have ben demonstrated even at 127 days.

Several papers dealing with the pathophysiology of radiation sickness should be noted. The participation of the CNS in pathology after very high doses of radiation has been reviewed by L. F. Semenov (51). In work on about 725 laboratory mammals, including a number of primates, it was found that early deaths after 10,000–30,000 r are due to brain damage. In monkeys the CNS syndrome threshold was found to be about 6000–15,000 r, while in cats the threshold was near 35,000 r. Commonly used chemoprotective agents did not seem to defend against the CNS syndrome, while narcotics and anesthetics often did prevent death within the first 48 hours. An interesting observation deals with the fact that very high whole body doses (10,000 r) may produce less marked leucopenia than moderate ones (2000 r), which perhaps suggests a CNS role in the white cell reaction.

Central nervous damage associated with human occupational radiation exposure has received attention in the Soviet literature. For example, Afanas'yev and Fateyeva (1) report on careful follow-up studies done at the Dubna synchro-cyclotron facility. Personnel exposures at this installation are said to have conformed with standards recognized during the 1950–1959 period and actually usually amounted only to 10–50 per cent of the existing limits. Findings in workers exposed under these conditions are said to include hypo- and hypertension, abnormal vascular lability, sensory polyneuritis, neurasthenic conditions, decreased olfactory sensitivity and diminution of color field size. Unfortunately, the experimental and control groups used for the study were not homogeneous in regard to age, and the observed deviations were present in a group containing distinctly more older persons than the con-

trol. It is therefore difficult to interpret the findings. Testing by "verbal conditioning" methods was also employed, and with similar results.

Drogochina and Ryzhkova devoted a special paper to radiation vasopathies (19). They studied a group subject to chronic occupational exposure, but do not cite the average doses involved. Findings included general neurasthenic symptoms of all types, fainting, tremors and nystagmus, labile or abnormal blood pressures, paresthesias, etc. Some of these workers had mild leucopenias and other objective changes.

Somewhat similar findings were noted by Kuznetsov (52) in a group of persons exposed to 5–10 times the maximum permissible limit for long times, under circumstances not detailed. These authors found "functional asthenic disturbances" with or without objective findings such as polyneuritis and decreased cortical ability.

Effects on experimental neuroses in primates and other animals are also said to demonstrate the great sensitivity of the CNS to radiation. It was reported to the 1959 Radiobiology Exchange Mission that after radiation in moderate doses, conditioned-conflict neuroses in monkeys are induced more easily, last longer and are more severe. As reported previously, Antipenko (52) observed this reaction in other laboratory animals.

On various occasions Soviet radiobiologists have suggested that the CNS is the most radiosensitive of all somatic systems and that occupationally exposed workers may suffer significant deviations of higher nervous abilities. No large-scale studies of this matter, controlled for age and other variables, have yet been seen in the Soviet literature.

CNS EFFECTS FOLLOWING ANTENATAL IRRADIATION

This type of study is distinctive in that possible CNS damage is sought following birth and maturation to adulthood. As is well known, the embryonic nervous system is more sensitive to radiation than its adult counterpart and it might be expected that very high radiosensitivities would be shown by functional methods after exposure *in utero*. In the reviewed papers, however, this has thus far not been the case.

I. A. Piontkovsky and his staff at the Institute of Higher Nervous Activity in Moscow have been responsible for much work of this type. Typical experiments involve giving pregnant rats tens or hundreds of r during gestation. It is observed parenthetically that such doses had no effect on the behavior of the mothers (50). Complex CR patterns were developed in the offspring when they reached adulthood. Exposure to 200 r produced minor but possibly significant alterations in certain parameters, such as the latent period for response to a test tone, the magnitude of response to other stimuli, etc. However, no significant change was observed in latent period of reactions to light, random motor activity between trials, and other parameters. It was noted that motor activity of exposed animals seemed to be increased during the third week of life in a rather consistent manner. The above alterations, when present, were in the range of 10–25 per cent of control values, and the entire experiment is probably notable for the lack of major changes in CR's after this substantial antenatal dose.

In other work Piontkovsky has given rats single doses of 200 r on the twelfth or eighteenth day of gestation. Animals subject to this treatment are said to reveal weakening of all cortical capabilities on reaching adulthood, manifested as failures of fine cortical inhibitory processes (differentiation, delayed reactions), poor behavioral control and unresponsiveness.

It has been pointed out by A. M. Ivanitsky (25) that the pathology after such acute radiation exposures may mimic certain heritable functional nervous disorders. His research also involved EEG studies on offspring from mothers getting single acute

doses of 300 r. The irradiated progeny showed significantly lowered mean EEG potentials, with greater depression of high frequency waves. Work with photic driving (flashing light) established that the irradiated animals were less reactive to stimulalation. Abnormal responses were seen and are said to indicate an altered cortical excitation-inhibition balance. Considerable care was taken to analyze the results and meaningful EEG alterations are shown in the accompanying materials.

M. M. Aleksandrovskaya, whose work on radiation pathomorphology in adult animals has been noted above, also studied the histology of animals exposed to 150–200 r *in utero*. It was corroborated that many animals exposed to such doses may develop gross congenital abnormalities, such as general brain atrophy, damage to certain specific cortical layers, hydrocephalus, etc. This author feels that the greatest damage occurs in structures proliferating actively at time of irradiation and is produced *via* an indirect toxicity or metabolic means.

In his review of low-level effects for the 1958 Geneva Conference, Lebedinsky (30) cites work by Yakovlev on the motor responsiveness of rabbit embryos after *in utero* irradiation with 25–200 r. This interesting study appraises the motor response of a fairly well-developed embryo to skin stimulation with a pin. After 50–200 r reactivity is considerably decreased; after 25 r there appears to be a lessening of responsiveness, but it is not so well marked. Mentioned in this review also is work on stimulation-response curves of motor and sensory nerves of rats that acquired body burdens of Sr-90 from their mothers during development. While all experimental conditions are not detailed, animals with final burdens of 0.16 to 0.6 μc of Sr-90 are said to show reactivity changes.

Another investigation of the effects of antenatal radiation from Sr-90 was performed by V. A. Nazarov (42). His experiments were performed on several dogs whose parents had been given 8–90 μc of Sr-90 over several years. The offspring appeared to develop positive CR's faster, but showed worsening of ability to differentiate, abnormal reactions to test agents such as caffein, and evidence of poor general cortical balance with unstable emotionality. It is estimated that *in utero* exposures here amounted to about 90–600 r. On the basis of presented data distinct alterations seem to be present after 600 r and probably following 230 r; after 90 r much doubt remains.

DISCUSSION

To develop an adequate discussion of the many experimental facts and scientific theories advanced above is difficult. An attempt nonetheless will be made to touch on the most important points, using the device of pertinent questions and their answers. It should be kept in mind that by no means all Soviet radiobiologists are Pavlovian physiologists, nor are they all in agreement that the CNS is outstandingly important in respect to radiation pathology.

Why has so much emphasis been placed on CNS effects by some Russian researchers? Classical Pavlovian physiology provides a clearly defined approach to any disease state; that is to say, it is analyzed as a disturbed relationship between the organism and the environment, keeping in mind that the most important function of the CNS, and particularly the cerebral cortex, is to mediate this relationship. Further, Pavlovian technique provides an excellent methodology for chronic physiological studies, *e.g.*, of gastric secretion after irradiation. In addition some Soviet scientists have thought that the CNS may be very radiosensitive and possibly disturbed even by the very low levels of radiation prevailing in the environment or during occupational exposure to radiation.

Has the Soviet work proven the CNS to be highly radiosensitive? No single answer is possible to this question: the Soviet work is not fully in agreement within itself. The

reader will have noted that some researchers maintain that CR's may be affected by a few r; while others say that essentially normal CR's can be formed after cumulative brain exposures of several thousands of r. Observers seeking one effect fail to note a different change mentioned in other reports. For example, Tsypin's work on the initial EEG response does not note any alteration in the EEG except for a very brief "spike" of some sort, yet prior papers by Livanov indicate that increased afferent inflow causes an early and lasting change in EEG activity. Many of the experiments reported above, especially those done at low levels, are very difficult procedures and clearly must be controlled with great care, as well as being subjected to rigorous statistical analysis. Some of the alterations reported may not represent pathology. For instance, it has been mentioned by Lebedinsky and others, that weak retinal stimulation occurs after radiation at dose levels below 10 r. This stimulation might affect the EEG, but it probably is not a damaging change. It thus appears premature to conclude that the CNS has been shown to be very radiosensitive from the viewpoint of specific radiation injury.

Has the CNS been proven to play a major role in some of the pathophysiological mechanisms arising after irradiation? That is, have disturbances in CNS function been demonstrated to produce pathology which is commonly attributed directly to cellular radiation damage? On the basis of the reviewed work it is difficult to answer this question in the affirmative. If such were the case major progress should have been made in preventing radiation injury by agents which act on the nervous system, such as stimulants or anesthetics, by surgical intervention before or after irradiation, and through selective shielding of the nervous system. Experiments have been done on all these areas and the available literature does not reveal any major therapeutic successes.

One of the more important arguments against a specific role by the CNS in radiation injury is the fact that no receptors for ionizing radiation have been demonstrated in mammals or other organisms. Once pathology develops in an organ, *e.g.*, following irradiation of the skin, the usual CNS reaction to local injury is naturally anticipated, but it is in no sense specific for radiation. Since the evolutionary adaptive basis of organismal response is considered by Soviet theorists to be very important, it is curious why the apparent contradiction noted above has not received much attention.

It also appears of importance that certain types of conditioned responses have not been obtained by Soviet scientists. For instance, if radiation is perceived by the CNS, one might expect to produce CR's in which it serves as the conditioned or signal stimulus, *e.g.*, as a warning of impending shock. No such CR's are described in the available literature. Again, there do not appear to be any experimental trials showing conditioned cancers or conditioned organ and tissue hypertrophy or atrophy. Some Soviet studies do indicate that mitotic rates are somewhat altered in denervated organs but such organs do not appear to either proliferate wildly or undergo major shrinkage.

On the basis of these considerations, it appears that future analyses of nervous system radiation damage must necessarily differentiate between the following categories of reaction.

Type of stimulation:

1) Non-pathological stimulation of a receptor, such as the retina.
2) Random non-pathological stimulation of other parts of the nervous system, as increased firing rates in neurons or axons.
3) Stimulation which is said to be specific for ionizing radiation and results in a purposeful adaptive reaction to radiation.
4) Stimulation associated with a change in function of an organ damaged by radiation.
5) Pathological stimulation, such as the

afferent over-activity described above, which leads to damaging physiological responses.

Type of damage:

1) Damage to certain parts or functions of the CNS, which is specifically the result of radiation.
2) Non-specific damage to the entire CNS, which might be considered similar to natural aging.
3) Damage to nervous elements resulting from or secondary to radiation organ injury, as of nerve endings in the spleen or gut.
4) Non-specific CNS derangements associated with altered levels of hormones or metabolites, or resulting from circulating toxins due to radiation injury.
5) Serious disturbances in autonomic control.

The use of this or some other similar classification would certainly be helpful in analyzing the findings from a given type of experiment on nervous system reactions to radiation.

How does the Pavlovian approach assist in demonstrating radiation injury? It is unfortunate that Pavlov has not been more widely read outside the USSR, because his work is clearly of great scientific importance. His theories of nervous system types or of cortical excitation and inhibition do not seem to be taught very widely in the Western world. The Pavlovian approach offers real advantages for certain types of radiation studies. For example, it provides a means by which a controlled reproducible response can be produced in an organ like the salivary gland. Conditioned trials after radiation would test the functional competence of the gland. Conditioning methods can be applied to all types of studies on the gastrointestinal tract and vasculature. As a single instance, Lebedinsky's experiments on autonomic function have sometimes included conditioned reactions.

In addition, the Pavlovian method provides a controlled means of observation which might be expected to bring out differences in reactivity following irradiation. In regard to behavioral studies, however, one wonders whether the deliberate conditioned response will be as revealing as observations of spontaneous behavior. A number of Western studies have demonstrated that voluntary acts, such as choice of food or volitional activity, bring out the earliest reactions to irradiation.

It is also of some interest that Biryukov finds that pigeons exposed to 2000 r were able to develop quite normal CR's, though showing overt postural disturbances. Catalepsy was abolished in the chicken by a dose which was said not to influence CR's.

Another important problem, seemingly intrinsic to the classical conditioned reflex approach, is that intensive work is done on a small number of animals, a situation which does not lend itself very conveniently to large-scale, low-level investigations. In addition, this makes statistical analysis difficult.

What is the significance of the above data for human population or occupational exposure? To this writer's knowledge, Soviet scientists have not urged that the existing radiation standards of the International Commission on Radiological Protection (ICRP) be modified to include CNS effects. The 1959 Exchange Mission was told that new Soviet protection standards will be based on the ICRP's current recommendations. It would appear therefore that Soviet radiobiologists do not feel that CNS effects are so important as to warrant revision of prevailing radiation standards. The available papers on effects in humans following exposure either deal with high level exposures or are not fully controlled, as in the case of work at Dubna, where the age distribution of the experimental and control groups was not identical. It is certainly to be hoped that if evidence on CNS radiosensitivity is found which may require alterations of radiation protection standards, it will be presented in the literature and be-

fore learned bodies at the earliest possible date.

Future work? Translations and abstracts of Russian publications are becoming more widely available and can be located easily through the *Nuclear Science Abstracts* and other sources. Therefore the scientist without Russian reading ability will find it increasingly feasible to follow Soviet CNS work. Particularly important progress may take place in some of the following areas: the relationship of local nerve injury to carcinogenesis after irradiation; radiation aging of the nervous system; the ability of the CNS to completely obscure some types of damage through adaptive compensations and the related question of threshold to radiation injury in the CNS; continuing basic work on nervous control of growth, regeneration, mitotic rates, etc.; further studies on mild CNS damage similar to functional disturbances caused by prenatal irradiation.

While one may not agree with some of the Soviet assertions on CNS radiosensitivity made in the studies here reviewed, future work in this area will no doubt produce an interesting yield. There appears little question that the nervous system must participate in some manner in so general a reaction as radiation injury.

SUMMARY

Reviews are presented of a number of recent (1958–1960) Soviet research papers on CNS effects of radiation. The large majority of articles considered have not been translated.

It is observed that there is no unanimity in the Soviet literature on the threshold of CNS radiosensitivity. Some observers claim important conditioned reflex alterations at a few r, while others are able to produce essentially normal reflexes after cumulative doses of many thousands of r. Certain researchers find an EEG effect at very low doses, indicating increased afferent inflow to CNS, while others observe transient responses or no effect after many hundreds of r.

Careful distinction must be made between various types of CNS reactions to radiation, such as retinal stimulation, which is without pathological significance, and outright damage to the CNS, which clearly is a detrimental result. A distinction should also be made between CNS reactions which produce somatic pathology, if any, and those which are caused by such pathology as a secondary reaction.

Because of the very complex nature of many of the experiments reviewed, whose full analysis requires very extensive controls and complete statistical analysis, no conclusion on the radiosensitivity of the CNS seems desirable at this time. Those functional changes in CNS activity which have been noted by Soviet scientists have generally been minor ones and not inappropriate to the general disturbed state of the organism after radiation exposure. Thus far Soviet researchers have apparently not proposed modifying existing international radiation protection standards on the basis of their investigations of CNS effects.

It is pointed out that Pavlovian techniques provide an elegant tool (and one which might well be more used by Western investigators) for certain dynamic studies of physiological processes sensitive to radiation. However, some of the most important radiation reactions, such as bone marrow depression, cancer production and genetic mutations, do not appear to be under very direct nervous control; and are therefore difficult to study by the Pavlovian method.

REFERENCES

1. Afanas'yev, V. P. and Fateyeva, M. N. Experience in the dosimetric control and clinical evaluation of workers at the "Joint Inst. for Nuclear Research at Dubna." Medits. Radiolog., **5**: 6–18, 1960.
2. Aleksandrovskaya, M. M. Certain data on the effects of ionizing radiation on the morphology of the central nervous system in animals. Trudy Inst. Vysh. Nerv. Deyatel., **4**: 211–24, 1958.

3. Alekseyeva, G. I. The condition of the receptor apparatus in the walls of large vessels following roentgen irradiation. Byull. Eksp. Biol. i Med (Moskva), **46:** 122–124, 1958.
4. Anisimova-Aleksondrova, V. V. Morphological changes in various components of the peripheral nervous system after exposure of the organism to ionizing radiation. Medits. Radiolog., **4:** 3–9, 1959.
5. Ardashnikov, S. N. and Rayt, M. L. Changes in the bioelectric activity of the cerebral cortex of the rabbit measured directly during inhalation of radon and after application of radioactive sources. Medits. Radiolog., **5:** 18–22, 1960.
6. Baskakov, V. P. The effects of penetrating radiations on higher nervous activity in animals. Medits. Radiolog., **4:** 10–13, 1959.
7. Belonsky, I. S. Changes in the higher nervous activity of rats during irradiation with roentgen rays. Medits. Radiolog., **4:** 11–16, 1959.
8. Biryukina, L. Long-term effects of exposure to small doses of radio-active substances in a chronic experiment. [Peaceful Uses of Atomic Energy] *Biological Effects of Radiation,* **22:** 29–45, United Nations, N. Y., 1958.
9. Biryukov, D. A. Data on the problem of the effect of penetrating radiation on central (nervous) inhibition. *Problemy Fiziologii Tsentral'noy Nervnoy Sistemy,* pp. 73–83. Medgiz, Moscow and Leningrad, 1957.
10. Biryukov, D. A. Problems concerning the interrelationships of the cerebral cortex and the internal organs. Fiziol. Zhurn im. I.M. Sechenov, **42:** 142–148, 1956.
11. Bokotova, N. A. and Gorbunova, I. M. Reflex changes in small-intestine mobility in response to the action of chemical stimuli and beta rays on the mucous membrane. Dok. Ak. Nauk, SSSR, **119:** 1046–1049, 1958.
12. Brodskaya, I. A. and Merkulova, I. P. Concerning late changes in the brain following roentgen irradiation. Vest. Roentg. i Radiol., **31:** 7–13, 1956.
13. Brodskaya, Ye. A. Reflex effects from internal organs on the functions of the gastrointestinal tract in irradiated animals. Arkhiv Patolog. (Moskva), **20:** 53–8, 1958.
14. Bykov, K. M. *The Cerebral Cortex and the Internal Organs* (Translation by W. H. Gantt). Chemical Pub. Co., New York, 1957.
15. Chernigovsky, V. N. and Yaroshevsky, A. Ya. Problem of the nervous regulation of the blood system in experiments and clinical practice. Terap. Arkhiv (Moskva), **29:** 69–85, 1957.
16. Delitsyna, N. S. Investigation of receptor function in irradiated portions of the body using experimental animals. Medits. Radiolog., **4:** 17–20, 1959.
17. Delitsyna, N. S. Studies on receptor action in irradiated areas of humans undergoing irradiation therapy. Medits. Radiolog., **4:** 73–76, 1959.
18. Delitsyna, N. S. Concerning some changes in receptor systems under the influence of x-ray. (Works of the All-Union Conference on Medical Radiology). Exper. Med. Radiol., AEC-tr-3661 (Book 1), pp. 51–60.
19. Drogochina, E. A. and Ryzhkova, M. N. Concerning vascular diseases (vasopathies) resulting from chronic radiation exposure to ionizing radiation. Klin. Medits. (Moskva), **37:** 46–50, 1959.
20. Garvey, N. N. Morphological changes in extroceptors of the skin exposed to penetrating radiations. Vest. Rentgen. i Radiol., **31:** 14–22, 1956.
21. Gaza, N. K., Dzidziguri, T. D. and Sergeyeva, I. V. Alterations introceptor reflexes from organs of the blood system in acute radiation sickness. Tr. Inst. Fiziol. im Pavlov (Moskva), **7:** 416–21, 1958.
22. Gorbunova, I. M. and Rokotova, I. A. Conditioned reflexes in dogs during local irradiation of limited areas of the skin or mucous membrane by beta rays. Dok. Akad. Nauk SSSR, **120:** 922–1025, 1958.
23. Grigor'yev, Yu. G. *Materials on the Reactions of the Central Nervous System to Ionizing Radiation.* Medgiz, Moscow, 1958.
24. Gromada, J. and Polachek, P. The influence of roentgen irradiation on certain portions of the peripheral nervous system. Medits. Radiol., **4:** 21–26, 1959.
25. Ivanitsky, A. M. Results of the second conference on the effect of ionizing radiation on segments of the central nervous system. Pat. Fiziol. i Eksp. Terap. (Moskva), **3:** 93–94, 1959.
26. Khozak, L. Ye. The influence of repeated exposures to roentgen rays on the higher nervous activity of animals (white rats). Tr. Inst. Vysh. Nerv. Deyatel., **4:** 114–131, 1958.
27. Korol'kova, T. A. Electrophysiological studies of the effects of ionizing radiation on the functional state of the cerebral cortex under normal and pathological conditions. Tr. Inst. Vysh. Nerv. Deyatel., **3:** 121–135, 1958.
28. Kotlyarevsky, L. I., Gorsheleva, L. S. and Khozak, L. Ye. The importance of nervous system type of an animal for the development and recession of changes in the nervous system activity due to ionizing radiation. Tr. Inst. Vysh. Nerv. Deyatel., **4:** 89–95, 1958.
29. Lebedinsky, A. V., Nakhil'netskaya, Z. N. and Smirnova, N. P. The participation of the vegetative nervous system in reactions of the organism to the effects of ionizing radiation. Medits. Radiol., **4:** 3–10, 1959.
30. Lebedinsky, A. V., Grigor'yev, Yu. G. and Demirchoglyan, G. G. On the biological effect of small doses of ionizing radiation. In *Peace-*

ful Uses of Atomic Energy, Vol. 22, pp. 17–28, United Nations, N. Y., 1958.

31. LEBEDINSKY, A. V. The participation of the vegetative nervous system in reactions of the organism to the effects of ionizing radiation. Medits. Radiolog., **4:** 3–10, 1959.
32. LEV, I. D. The condition of synaptic structures of nerve cells in the spinal cord of the irradiated rat. Byull. Eksp. Biol. i Med., **44:** 109–113, 1957.
33. LEVINSON, L. B., PANKOVA, N. V. AND SHAPIRO, N. I. The effects of roentgen irradiation on the duodenum and intramural auerbach ganglia and meissner plexi. Dok. Ak. Nauk, SSSR, **116:** 404–406, 1957.
34. LIVANOV, M. N. Changes occurring within different parts of the central nervous system after exposure to x-rays. *Works of the All-Union Conference on Medical Radiology, Experimental Medical Radiology,* AEC-tr-3661, pp. 30–39, 1959.
35. LIVANOV, M. N. AND BIRYUKOV, D. A. Changes in the nervous system caused by ionizing radiation. *Peaceful Uses of Atomic Energy, Vol. 22,* pp. 269–281, United Nations, N. Y. 1958.
36. LOMONOS, P. I. Cortical regulation of the vomiting reflex following radiation. Fiziol. Zhurn. SSSR, im. Sechenov, **45:** 157–162, 1959.
37. MALYUKOVA, I. V. The effects of small doses of roentgen rays on extinction inhibition in mice. Tr. Leningrad San.-Hyg. Med. Inst., **44:** 342–49, 1958.
38. MASLOVA, A. F. Concerning alterations in concentrations of the adrenaline and adrenaline-like substances in the blood and chamber of the eye of the rabbit following whole-body irradiation. Medits. Radiolog., **4:** 36–41, 1959.
39. MASLOVA, A. F. Modification of the adrenaline content in the blood and aqueous humor in the rabbit following irradiation. Byull. Eksp. Biol. i Med. (Moskva), **46:** 81–4, 1958.
40. MESHCHERSKY, R. M. The influence of local irradiation to the cortical terminus of the visual analyzer of the rabbit on motor defense reflexes developed to light stimuli. Tr. Inst. Vysh. Nerv. Deyatel., **4:** 79–86, 1958.
41. MOZZHUKIN, A. S. Changes in reflexes from the cartoid sinus in acute radiation sickness. Medits. Radiolog., **4:** 32–36, 1959.
42. NAZAROV, V. A. Changes in the conditioned reflex activity of the offspring of dogs subject to chronic Sr-90 exposure. Medits. Radiolog., **4:** 13–17, 1959.
43. OLEYNIKOVA, T. N. Morphological changes in the peripheral nervous system in animals at remote periods after radiation sickness. Fiziol. Zhurn. (Kiev), **5:** 104–8, 1959.
44. PAVLOV, I. P. *Conditioned Reflexes* (Translation by G. V. Anrep). Dover Publications, New York, 1959.
45. PIONTKOVSKY, I. A. Basic viewpoints of the radiobiological investigations at the institute of higher nervous activity. Tr. Inst. Vysh. Nerv. Deyatel., **4:** 3–11, 1958.
46. PIONTKOVSKY, I. A. Proceedings of the second scientific conference on the problem of the effects of ionizing radiations on higher portions of the central nervous system. Patol. Fiziol. i Eksp. Terap. (Moskva), **3:** 93–94, 1958.
47. PSHENNIKOVA, M. G. Electrophysiological analysis of the distribution of non-impulse effects in nerve-muscle preparations from roentgen-irradiated regions of the organism. Biofizika (Moskva), **3:** 680–88, 1958.
48. SAMOYLOVA, L. G. Certain mechanisms involved in the effects of small doses of chronic whole-body radiation on higher nervous activity and certain vegetative functions in white rats. Medits. Radiolog., **4:** 13–17, 1959.
49. SCHASTLIVTSEVA, A. A. Changes in the nerve apparatus of the spleen after the experimental irradiation of animals. Medits. Radiolog., **4:** 82–84, 1959.
50. SEMAGIN, V. N. The state of higher nervous activity in the rat after daily roentgen irradiation during the embryonal period of development. Medits. Radiolog., **4:** 16–21, 1959.
51. SEMENOV, L. F. The development of the most acute form of the radiation syndrome. Medits. Radiolog., **3:** 70–76, 1958.
52. STAHL, W. R. A review of Soviet research on the central nervous system effects of ionizing radiation. *J. Nerv. Ment. Dis.,* **129:** 511–529, 1959.
53. TONKIKH, A. V. AND YANKOVSKAYA, L. T. Concerning changes in the activity of the medullary layer of the adrenals in organisms exposed to ionizing radiation. Medits. Radiolog., **4:** 25–29, 1959.
54. TSYPIN, A. B. AND GRIGOR'YEV, YU. G. Quantitative characteristics of the sensitivity of the central nervous system to ionizing radiation. Byull. Eksp. Biol. i Med. (Moskva), **59:** 26–30, 1960.
55. VIKHERT, T. M. Experimental studies of reactive changes in the brain following administration of radioactive colloidal gold. Medits. Radiolog., **4:** 56–63, 1959.
56. YARULLIN, KH. KH. Changes in higher nervous activity in experimental chronic radiation sickness induced by ionizing radiation. Medits. Radiolog., **4:** 16–21, 1959.
57. YANSON, Z. A. Electrophysiological study of the changes occurring in conditioned reflex activity of rabbits after total and partial body exposure to x-rays. *Works of the All-Union Conference on Medical Radiology, Experimental Medical Radiology,* AEC-tr-3661, pp. 40–50, 1959.
58. ZAYRAT'YANTS, B. V. Pathomorphological changes in the gastro-intestinal tract during chronic radiation sickness. Medits. Radiolog., **5:** 35–42, 1960.

BODY-IMAGE DISTURBANCES IN CHRONICALLY ILL INDIVIDUALS[1]

STEPHEN L. FINK, PH.D.[2] AND FRANKLIN C. SHONTZ, PH.D.[3]

The importance of understanding the nature of the body-image, from both a theoretical and practical point of view, was emphasized by Fisher and Cleveland (4) when they stated that "the body-scheme may function as a basic standard or frame of reference which influences some of the individual's modes of perception and also his ability to perform certain skills." In the field of rehabilitation of the chronically ill, study of the body-image has become especially important, since the process of rehabilitation requires that a patient relate his body to objects in the environment (*e.g.*, a wheelchair, crutches, parallel bars, etc.) and, therefore, requires that he be aware of his body and of the relative positions of the various parts of his body.

A number of investigations of body-image disturbance have employed groups of hemiplegics as the subjects (1–3, 6, 7, 9–11). Most of these studies have attempted to interpret observed disturbances in terms of the organic brain deficit known to occur in hemiplegia. Very few have attempted to control for disturbance which may be associated more directly with the overall loss of body functioning characteristic of chronic illness. In hemiplegics, as well as in almost any other group of disabled persons, the amount of physical activity and interaction with the environment is markedly lowered by the limitations imposed by the physical disability. Schilder (8) emphasized, "We can have a postural model of our body only when we get sufficient data. . ." While the body-image itself is presumably a central process, the data upon which it depends may come by way of peripheral avenues, and disruption of these avenues will certainly affect the central process. The same point of view has recently been emphasized and elaborated in an article by Gerstmann (5). Therefore, in any study of body-image disturbances in hemiplegics it is crucial to evaluate possible effects of chronic disability in general before drawing conclusions about brain damage specifically.

The present investigation was designed to test certain hypotheses regarding alleged differences between physically healthy and chronically ill individuals in body-image functioning. This paper represents a report of the findings in regard to two major research hypotheses:

1. Hemiplegic individuals show greater body-image disturbance than non-hemiplegic non-brain-damaged persons; and

2. Chronically ill non-hemiplegic non-brain-damaged persons show greater body-image disturbance than physically healthy persons.

The two hypotheses together predict an ordering of body-image disturbance, from least to most, which places the three groups in the order: physically healthy persons, chronically ill non-hemiplegic non-brain-damaged persons, and hemiplegics. It should be noted that the question of the presence or absence of brain damage in the groups had to be considered in a relative sense only. The diagnosis for each subject was dependent upon available medical and psychological information; where this information failed to

[1] This paper is a condensed version of a research report submitted by S. L. Fink in partial fulfillment of the requirements for the degree of Doctor of Philosophy, at Western Reserve University. A report of this research was presented at the 1959 meeting of the Midwestern Psychological Association in Chicago, May, 1959. The project was carried out at Highland View Hospital, Cleveland, Ohio, and was financially supported by the Cleveland Foundation.

[2] Highland View Hospital, Cleveland, Ohio; Department of Psychology, Western Reserve University, Cleveland, Ohio.

[3] Program in Somatopsychology, University of Kansas, Lawrence, Kansas.

indicate the presence of measurable brain damage it was assumed that gross damage of this type was not present. Although it was recognized that varying degrees of cortical deterioration are likely to be present in the kinds of subjects employed in this study, especially since they represented the upper age brackets, it was felt that the groups, as groups, were fairly distinct in this respect.

The investigation employed double simultaneous tactual stimulation as the stimulus variable and judgements of related visual distance as the response variable. It was assumed that the process of translating a stimulus presented to the body into a visual dimension (*viz.*, distance), when direct visual contact with the body is not permitted, is a function of the individual's ability to picture the stimulus on his body; *i.e.*, it is a function of the individual's body-image. It is important to emphasize that the present study focusses upon the *pictorial* aspects of the body-image concept. No attempt was made to include measures of feelings or attitudes toward the body; the primary interest was in measuring the ability of the subjects to picture, or represent along a spatial dimension, their own physical bodies.

METHOD

SUBJECTS

The physically healthy group was composed of twelve male and twelve female members of the Golden Age Club of Cleveland; the mean age was 69.2 (SD = 6.5). The non-hemiplegic patient group was composed of twelve males and twelve females with a mean age of 71.0 years (SD = 10.2). It consisted of sixteen patients with hip or limb fractures, four arthritics, one person with a lower leg amputation, one with arteriosclerosis, one with multiple sclerosis, and one with Charcot's disease. Every patient was wheelchair-bound at the time he was seen and none had been diagnosed as brain-damaged. The hemiplegic group contained twelve left and twelve right hemiplegics, evenly split into males and females. Only those patients who were capable of perceiving and indicating that they could perceive tactual stimulation in all body areas relevant to the experimental measures were included in the study. It was necessary to exclude right hemiplegics who suffered from receptive aphasia and thus were not capable of comprehending the instructions of the examiner. It was also necessary to exclude patients suffering from hemionopsia. As a result, the sample was somewhat biased in favor of hemiplegics who were not grossly deteriorated. The mean age of the group was 67.1 (SD = 11.6).

In order to provide some control for the factor of intelligence in comparing the groups, the Columbia Mental Maturity Scale was administered to each subject. This particular test was selected for several reasons. It purports to measure an individual's abstract conceptual abilities, which is especially relevant to the present study; it requires a minimum of both verbal and manual functioning, thereby permitting evaluations of all subjects without posing any special handicap for patients with motor and/or verbal expressive difficulties; and it may be administered in a relatively brief period of time and, therefore, tends not to impose excessive demands upon patients who fatigue easily. The mean Columbia score for the physically healthy group was 65.1 (SD = 8.5); for the non-hemiplegic patient group it was 58.4 (SD = 13.8); and for the hemiplegic group it was 63.2 (SD = 8.9). In an analysis of variance on the Columbia scores the between-groups variance was not statistically significant. It might also be noted that the hemiplegic group, which could be expected to show a deficit in Columbia performance, fell closer to the physically healthy group than did the non-hemiplegic patients.

EXPERIMENTAL SITUATION

A table which could be adjusted to various heights was placed at a distance of forty-four inches from a blank wall. The subject

was seated behind the table facing the wall. A flashlight designed to focus a vertical strip of light on the wall was attached to the table, with a handle for turning the light within easy reach of the subject. The arrangement permitted the light to be turned in a horizontal direction. A strip of white tape, the same size as the strip of light, was fastened to the wall, opposite the center of the table. The room was in a semidark state, and both the light strip and tape strip were clearly visible to the subject. A cloth sheet was attached to the table and tied around the subject's neck, so that he could not see any portion of his body below the neck. A pair of wooden calipers was used as the stimulus; the caliper setting under each condition of the study served as the objective standard for each subjective response.

PROCEDURE

The body-image test consisted of requiring each subject to adjust the distance between the two visually perceived points (the light strip and tape strip) to correspond to the distance between two points indicated (with the calipers) on his body. Three different stimulus sizes, eight, twelve and eighteen inches, were distributed among eighteen body-region combinations. Left unilateral, right unilateral and bilateral body areas were sampled and equally balanced throughout. The order of the conditions was randomized for each subject. A test of visual perceptual discrimination, using the same three caliper settings, was employed in order to control for possible disturbances in this sphere. In this test, the task consisted of presenting the two-point stimuli visually and requiring the subject to make the same response as in the body-image test.

The measures of interest were the deviations of the light setting responses from their corresponding stimulus values. A logarithmic transformation was performed on all responses in order to render deviation values perceptually equivalent on an equal interval scale. The transformation formula was 100 log X/18 where X was the raw score response in inches. This transformation converted the 8, 12, and 18 inch raw values into equi-distant values (5, 6, and 7) on the transformed scale. The method is consistent with general psycho-physical methodology where it is necessary to transform perceptual discrimination responses, which occur on a ratio or geometric scale, into an equal interval or arithmetric scale. The logarithmic values were considered, in the present study, to be the "raw data" of the project. The groups were compared, by means of analysis of variance, on both constant and average errors from the visual perception and body-image tests. It should be added that in order to obtain an average error for a given subject, it was necessary to analyze the raw data for the presence of possible systematic effects associated with the experimental conditions (the body locations and stimulus sizes) and to correct the data for these effects wherever they proved to be significant. An analysis of variance applied to the raw data provided the means of evaluating these effects and for correcting the scores accordingly. Only after these corrections were made was it legitimate to average the deviations around their respective means.

The research hypotheses applied to the average error values, which were assumed to reflect the *stability* of the responses. It was assumed that larger average errors indicated greater disturbance, *i.e.*, less stability. No predictions were made regarding the constant errors, but it was recognized that this variable might also serve as an index of disturbance. It remained to be determined whether chronic illness tended to result in an *inflation* of judgments about the body (*i.e.*, a constant error in a positive direction), in a *constriction* of the judgments (*i.e.*, a constant error in a negative direction), or in no change of this kind.

In the analysis of the constant errors, the values which were entered into the cells were the subjects' mean constant errors in the visual perception and body-image tests, a

total of 144 scores. The analysis of the average errors involved analogous values, again a total of 144 scores. Inspection of the data revealed that the between-subjects variances within the groups were not homogeneous or normally distributed; this was true of both the constant and average errors. It was necessary to apply a square root transformation to all the scores in order to meet the assumptions of analysis of variance.

TABLE 1

*Analysis of Variance Results: Constant Errors**

Source of Variance	df	Mean Sq.	F	p
Groups	2	59.0	2.7	ns
Conditions	1	56.0	8.4	<0.01
Groups by Conditions	2	62.5	9.3	<0.01
Subjects within Groups	69	22.0	3.3	<0.01
Error	69	6.7		
	143			
Physically Healthy vs. Non-Hemiplegic Patients (body-image scores)			11.2	<0.01
Physically Healthy vs. Hemiplegics (body-image scores)			34.9	<0.01
Non-Hemiplegic Patients vs. Hemiplegics (body-image scores)			6.6	<0.025

* Based upon values obtained after square root transformation.

RESULTS

Table 1 shows the results of the analysis of the constant errors; the term "Conditions" refers to the two types of tests, the visual perception and body-image tests. All three groups differed significantly in the body-image scores, but not in the visual perception scores. This finding is reflected in the fact that the interaction of "Groups by Conditions" was significant, while the term "Groups" was not; *i.e.*, the differences among the groups was significant for one condition (body-image) and not for the other (visual perception). The physically healthy group had the highest constant error, the hemiplegics had the lowest constant error, and the non-hemiplegic patients fell in the middle on the body-image test, reflecting a progressive *constriction*, from group to group, in the responses. Figure 1 shows the mean response (on the logarithmic scale) of each group on both tests. The mean stimulus value for all conditions was twelve inches, which was 6.0 on the log scale. Relative to this value it may be noted that the physically healthy group tended to overestimate the stimulus, while the disabled groups showed underestimations of the stimulus. It should be pointed out that the physically healthy group's responses were employed as the standard for interpreting the responses of the other groups, and, therefore, the term "constriction" applies to the responses of the disabled groups taken relative to the healthy standard. To employ the actual stimulus values as the "standard of reality" would require the evaluation of the effects upon perception of various testing conditions, particularly the conditions chosen for this study, as well as making assumptions about the relationship between measured distance and perceived distance. It may be noted that the differences among the groups fell almost on a straight line, indicating approximately equal intervals of body-image constriction.

Table 2 shows the results of the analysis of the average errors. Again all three groups differed significantly in the body-image scores and not in the visual perception scores. This finding is reflected in the significant interaction of "Groups by Conditions." The fact that the term "Groups" tested out as significant was evidently an artifact of the data related to a trend in the visual perception average errors which paralleled the body image average errors. The groups fell in the order predicted, on the body-image values, supporting both hypotheses. The physically healthy group had the smallest average errors, the hemiplegics had the largest, and the non-hemiplegic patients fell in the middle on the body-image test.

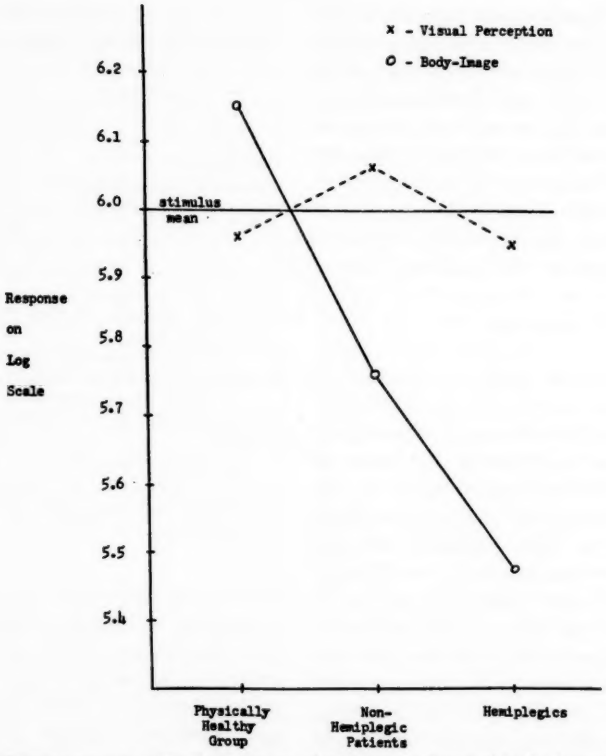

FIG. 1. Mean response of each group on visual perception and body-image tests.

TABLE 2

*Analysis of Variance Results: Average Errors**

Source of Variance	df	Mean Sq.	F	*p*
Groups	2	13.57	10.6	<0.01
Conditions	1	73.10	54.3	<0.01
Groups by Conditions	2	4.82	3.8	<0.05
Subjects within Groups	69	1.23	1.0	ns
Error	69	1.28		
	143			
Physically Healthy vs. Non-Hemiplegic Patients (body-image scores)			10.2	<0.01
Physically Healthy vs. Hemiplegics (body-image scores)			26.3	<0.01
Non-Hemiplegic Patients vs. Hemiplegics (body-image scores)			3.8	<0.05

* Based upon values obtained after square root transformation.

Figure 2 shows the mean average error (on the logarithmic scale) for each group on both tests. Again the differences fell along an almost straight line, reflecting approximately equal intervals of body-image instability.

The significant difference between the conditions in the constant errors could be accounted for by the changes, from group to group, which occurred in the body-image values while the visual perception values remained fairly constant. This same factor operated in the average errors, but it may be observed in Figure 2 that the body-image test yielded larger average errors than the visual perception test in all three groups.

No significant relationships were found between body-image disturbance and age or body-image disturbance and intellectual level.

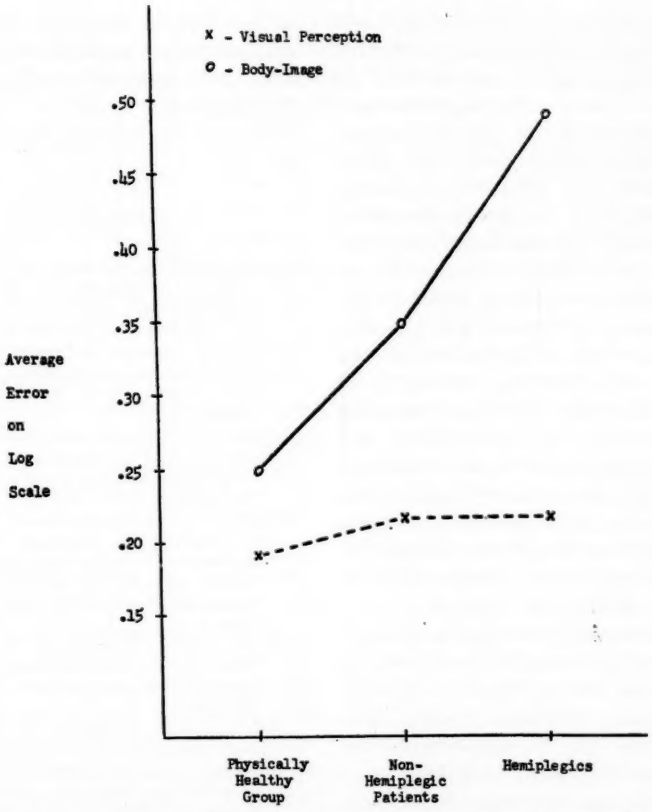

FIG. 2. Mean average error of each group on visual perception and body-image tests.

DISCUSSION

The present study demonstrates clearly that chronic disease tends to have associated with it measurable disturbances in the body-image, and that these disturbances occur even where there are no indications of serious cerebral damage beyond that attributable to age alone. The nature of the disturbance seems to involve a loss of stability in judgments about distances between body parts and in a tendency toward constriction of the size of these judgements.

Even though the hemiplegics exhibited greater body-image disturbance than the other patient group, this finding can only tentatively be interpreted to be the result of actual cerebral damage. It is the authors' impression that hemiplegia tends to be a more functionally disabling illness than those illnesses that were characteristic of the non-hemiplegic patient group. On this basis one would expect to find greater body-image disturbance in hemiplegics even after correcting for that which might be due directly to central deficit.

The best theoretical analysis of the present results is that the body-image is the product of mutually communicating central and peripheral processes. The peripheral processes obtain and deliver the raw data of active and passive sensation to the central system. The central system processes and integrates

this data and, in turn, provides feedback and control for the peripheral nerve network. Gerstmann (5) suggests the parietal or parieto-occipital area as the possible locus of the central system in this type of analysis.

The body-image phenomenon may, therefore, be expected to be altered by either central or peripheral changes in the overall system. Disturbance in the body-image may result from either direct damage to the central mechanism or damage to any of the peripheral sources of information. Conceivably, this latter type of damage results in a weakening, or eventual loss, of central associative connections; and this weakening becomes manifested in a reduction in stability of judgments about distances between body parts. The phenomenon of *constriction* may be construed to represent a shrinking of the overall body-image, the process occurring because of the loss of sustaining input to the central processing mechanism.

Implicit in this interpretation is the possibility that in those cases where the central system may be assumed to be relatively intact, substitute peripheral avenues may serve to provide data in compensation for the loss of input associated with the relative disuse of sensory-motor pathways. In other words, the central processes may be strengthened or, perhaps, reactivated by supplying information through sources other than the damaged ones. Where chronic disease destroys muscular functioning and thus eliminates feedback from behavior dependent upon this functioning, the stability of the body-image conceivably may be maintained by increasing, for example, the amount of direct visual contact the individual has with his own body. Over and above the theroretical implications, there is probably little question as to the potential practical value research in this area has in relation to the rehabilitation of the chronically ill.

REFERENCES

1. Bender, M. B., Shapiro, M. F. and Fink, M. Patterns of perceptual organization with simultaneous stimuli. A.M.A. Arch. Neurol. Psychiat., **72:** 233–255, 1954.
2. Cohn, R. Role of the "body-image concept" in the pattern of ipsilateral clinical extinction. A.M.A. Arch. Neurol. Psychiat., **70:** 503–510, 1953.
3. Denny-Brown, D., Meyer, D. and Horenstein, S. The significance of perceptual rivalry resulting from parietal lesion. Brain, **75:** 433–471, 1952.
4. Fisher, S. and Cleveland, S. *Body Image and Personality.* Van Nostrand, Princeton 1958.
5. Gerstmann, J. Psychological and phenomenological aspects of disorders of the body image. J. Nerv. Ment. Dis., **126:** 499–512, 1958.
6. Jaffe, J. and Bender, M. B. The factor of symmetry in the perception of two simultaneous cutaneous stimuli. Brain, **75:** 167–176, 1952.
7. Prater, G. F. A comparison of the head and body size in the drawing of the human figure by hemiplegic and non-hemiplegic persons. Unpublished master's thesis. Univ. of Kentucky, 1950.
8. Schilder, P. *The Image and Appearance of the Human Body.* Routledge, London 1935.
9. Shontz, F. C. Body concept disturbances of patients with hemiplegia. J. Clin. Psychol., **12:** 693–295, 1956.
10. Shontz, F. C. and Fink, S. L. The measurement of body concept disturbances in hemiplegic individuals. Unpublished study. Highland View Hospital, Cleveland, 1956.
11. Teitelbaum, H. A. Psychogenic body-image disturbances associated with psychogenic aphasia. J. Nerv. Ment. Dis., **93:** 581–590, 1941.

ATTITUDES OF AUXILIARY PERSONNEL ADMINISTERING ELECTROCONVULSIVE AND INSULIN COMA TREATMENT: A COMPARATIVE STUDY[1]

WILLIAM C. RUFFIN, JR.,[2] M.D., J. T. MONROE, JR., M.D.[3] AND GORDON E. RADER, PH.D.[3]

During the quarter century since the introduction of shock therapies there has been considerable controversy concerning their mechanism of action. In fact, as much as ten years ago, Gordon (6) was able to list fifty theories almost equally divided between psychodynamic and somatic explanations. While the present study does not attempt to engage in this controversy directly, it does stem from the pyschodynamic assumption that the total treatment configuration is significant. A particular segment of this configuration has been selected for further investigation: the attitudes of auxiliary personnel toward patients receiving insulin coma and electroconvulsive therapy and toward the treatment methods themselves.

Many authors have commented upon the importance of psychological factors in the treatment situation. Hill (7) notes that "from the start of insulin therapy it was apparent that the psychological atmosphere of the unit was a factor of supreme importance in determining results." In the same communication he quotes E. A. Bennett: "In my opinion, so much depends on how the treatment is presented to the patient, and this is more important than the bare bones of the treatment itself." Among others, Boyer (4), Fisher, Fisher and Hilkevitch (5), Abse (1), Blek and Navron (3), and Abse and Ewing (2), have emphasized the psychological implications for the patient of the somatic therapies.

A number of authors have pointed to the role of the therapists' attitudes in these somatic treatments. Wayne (8) observes that treatment measures run a gamut from mild, gentle ones to these harsh and rigorous, and believes that the characteristics of a treatment can evoke unconscious responses in the physician which may be quite obscure to him. More recently, Abse and Ewing studied the counter-transference attitudes common among shock therapists. It was concluded that the briefer therapies, for example electroconvulsive treatment, lent themselves to the development of hostile, punitive attitudes on the part of the therapist, whereas a therapy such as insulin engenders a more loving and caring attitude. However, little attention seems to have been paid in the literature to the reactions of nurses and attendants to these treatments and, as Abse and Ewing note, they are frequently more intimately and continuously in contact with the patient than the shock therapist himself. In some settings, including some observed by us, the shock therapist, although important in fantasy, may have no real interpersonal relationship with the patient. Indeed, he may never have met him.

The purpose of the present study was to investigate the attitudes and feelings of auxiliary personnel toward electro-shock and insulin treatments and the patients who are treated by these methods. Based upon the studies mentioned, two hypotheses were formulated. First, it was hypothesized that insulin coma treatment would be found to serve as a convenient channel for the expression of loving and caring attitudes. Secondly, it was hypothesized that personnel would

[1] The authors wish to thank the following persons: Dr. D. Wilfred Abse and Dr. John A. Ewing for stimulation and valuable assistance; Miss Joan Williams and Dr. Hans H. Strupp for rating the interviews; Dr. Walter A. Sikes, Superintendent, State Hospital at Raleigh, N. C. and Dr. James Cathell, Superintendent, Murdoch Hospital, Butner, N. C. for cooperatively allowing us to use their facilities.

[2] Department of Psychiatry, University of Florida College of Medicine, Gainesville, Florida. This report has been adapted from a paper presented at the Regional Research Conference, Little Rock, Arkansas, March, 1959.

[3] Department of Psychiatry, University of North Carolina School of Medicine, Chapel Hill, North Carolina.

more frequently regard electroconvulsive as a more punitive or controlling type of therapy.

METHOD

This investigation was carried out over a period of twenty-four months in two large state hospitals. In each hospital, nurses, student nurses and attendants assisting with electroconvulsive treatment and insulin coma treatments were interviewed for twenty to thirty minutes each by one of the senior investigators. In all, fifty-nine interviews were held with fifty different subjects. Nine of the subjects had worked extensively with both methods of treatment. The ratios of male to female personnel were about equal for the two groups, being 9:16 for the electroshock personnel and 11:23 for the insulin group. The two groups seemed generally comparable in other respects as well, and there is no reason to believe that a difference in composition of the groups influenced the results. An effort was made to make the interviews as comparable as possible without disrupting the free, informal atmosphere conducive to the most relaxed and cooperative attitude on the part of the subjects. Therefore responses were elicited in each interview within the following areas relating to treatment, though not necessarily in this order.

1. Impression about the treatment prior to beginning work on the ward.
2. How they came to work with the specific form of therapy.
3. Attitudes toward the patients getting therapy compared with those not getting treatment.
4. Fantasies of real and imaginary dangers in the therapy.
5. Concerns and feelings during different phases of the treatment.
6. Feelings regarding the special attention necessary for these patients.
7. Feelings regarding the potential complications of the therapy.

Every effort was made to avoid leading or influencing the respondents in any way, and the interviewers tried to be alert to the danger of a selective bias in their recording. In spite of these cautions, the nature of the interview and recording techniques employed did not rule out possible unconscious effects of the authors' attitudes and expectations.

The relevant statements of each subject were separately typed with the deletion of all direct references to the specific type of treatment under discussion. It was not possible to avoid some indirect statements that may have identified the treatment in a number of the interviews since these statements were so intimately connected with the expression of the feelings of the personnel being interviewed. These typed interview materials were then presented in randomized order to two clinical psychologists who independently rated each interview on two scales, shown in Table 1.

One of the two psychologists was familiar with the general aims of the study but did not know the specific source of any of the interviews. His ratings were used only to establish the reliability of the rating method. The second psychologist knew nothing of the purpose of the study, and was only informed that "the interviews are summaries of the comments of different sorts of personnel on the psychiatric wards of a state hospital concerning their feelings about various forms of therapeutic approach and about the patients who receive these treatments." The ratings of this second judge constitute the first quantitative data of the study.

Some further, more refined ratings were suggested by a consideration of the results of the original ones. Since these additional ratings, and the reasons for them, are better understood in the context of a discussion of the results of the first ratings, presentation of this additional aspect of the study is reserved for the next section.

RESULTS

Table 2 presents the distribution of interviews in which the treatment was positively viewed as compared with those in which the

TABLE I
Rating Scales Applied to Interview Material

A. *Attitudes Toward Treatment*

1	2	3	4	5	6	7
Strongly negative (worthless, dangerous, disgusting, etc.)	Moderately negative	Mildly negative	Neutral	Mildly positive	Moderately positive	Strongly positive (very beneficial, a great advance, etc.)

B. *Attitudes Toward Patients*

Strongly negative (hostile, punitive)	Moderately negative	Mildly negative	Neutral	Mildly positive	Moderately positive	Strongly positive (protective, affectionate, succorant)

TABLE 2
Attitudes Toward Treatment

Treatment	Neutral or Negative (Ratings 1–4)	Positive (Ratings 5–7)
Electroconvulsive	16	9
Insulin	27	7

TABLE 3
Attitudes Toward Patients

Treatment	Neutral or Negative (Ratings 1–4)	Positive (Ratings 5–7)
Electroconvulsive	12	13
Insulin	11	23

personnel expressed either neutral or negative attitudes toward treatment. Attitudes toward both types of treatment were more frequently rated as either neutral or negative. However, a smaller proportion of insulin ward personnel had predominantly positive things to say about this treatment than did those concerned with administering electroconvulsive treatment. In other words, insulin treatment was liked less than electroconvulsive treatment. However, the differences are so small that they could fairly easily have occurred by chance.

Table 3 presents a similar breakdown of attitudes toward patients. These are the attitudes expressed by the personnel of each type of treatment toward the patients receiving these treatments. Here a greater proportion of the insulin ward personnel were seen as expressing positive attitudes toward their patients as compared with the personnel of the electroconvulsive wards. This suggests some support for the hypothesis but again this tendency was not sufficiently pronounced to rule out the possibility that it was merely a chance finding.

These findings, in spite of good reliability for the rating procedures (reliability coefficients of .75 and .76), were somewhat surprising. Our subjective impressions in reading over the interviews had led us to expect more pronounced differences, at least with regard to attitudes toward patients. We returned to our original data to see if we could determine what had occurred. Again we were impressed that certain types of statements were frequently heard from personnel giving electroshock, but were either rarely or never heard from those involved in insulin coma treatment. For example, a few statements of the electroshock group were the following.

> "I was glad to see it come this week; the ward was so upset since there was no treatment for a week due to the Christmas holiday. One patient continually wanted pills and whined and complained; now he is better."
>
> "It makes hard to manage patients easy to manage."
>
> "When patients are combative, destructive, and violent they need to go on treatment and get some of that knocked out of them."

Such statements seemed to clearly indicate the controlling, punitive attitudes often involved in the application of electroshock. Although this was a primary interest of the research it became evident that the original

TABLE 4
Perception of Treatment as Controlling or Punitive

Treatment	No	Yes
Electroconvulsive	18	7
Insulin	34	0

rating scale of "Attitudes Toward Treatment" had not been specifically designed to identify this particular conception of the treatment. Rather, the rating was based first upon whether the interviewee felt the treatment improved patients and secondly upon the amount of suffering which the patients were forced to undergo in taking treatments.

To provide unbiased evidence of the neglected variable, another uninformed judge (again a clinical psychologist) was asked to sort the interviews according to the following instructions:

1. Give a (+) to any interview in which the treatment being discussed is viewed as a means of either controlling or punishing patients.
2. Give a (0) to any interviews in which such a perception is not apparent.

The results of this sorting procedure[4] are presented in Table 4. Not one of the 34 insulin ward personnel was judged to look upon this treatment as a means of controlling or punishing difficult patients. However, nearly a third of the twenty five electroconvulsive personnel regarded shock as a controlling or punitive device. This result is significant at the .001 level.[5]

With regard to the results of the second rating scale, concerning attitudes of the auxiliary personnel toward their patients, we were again impressed with the relatively much greater frequency by the insulin ward personnel of expressions of protective and motherly attitudes such as:

"When the patient is quiet, I sometimes feel like I do around small children, sort of motherly."

"During treatment I have a feeling like mother-instinct, want to help and protect them."

"I feel motherly and protective."

"I feel toward all patients like an old mother-hen."

"I wanted to give them more attention; they looked so helpless when coming out, more like a child. I wanted to do something for them."

Analyzing what went into the rating of positive or negative attitudes toward patients, it again was clear that we had not defined our rating scale specifically enough. In addition to mothering, caring attitudes we were dealing with general expressions of friendly, although not succorant, attitudes. Furthermore, a large contribution to positive ratings was made by those expressing sympathy or empathy for the patients undergoing the extreme unpleasantness of the treatment. Many of the positive ratings in the electroshock group were clearly based upon such sympathetic responses.

To again provide a more explicit check of our clinical impressions we asked the uniformed judge to sort the interviews according to the following directions:

1. Give a (+) where the respondent seems to be expressing motherly and caring attitudes towards patients (*do not give* a plus when merely friendly, sympathetic, or empathic attitudes are expressed).
2. Give (0) to any interviews in which the respondent does not express motherly, caring attitudes, *even though other types of positive attitudes are evident.*

The results of this sorting procedure are presented in Table 5. Nearly two-thirds of the insulin personnel were rated as expressing motherly attitudes as compared with only

TABLE 5
Expression of Motherly, Caring Attitudes

Treatment	No	Yes
Electroconvulsive	17	8
Insulin	13	21

[4] Reliability of this sorting procedure is high. There was .94 agreement with an independent judge.

[5] Fisher's Exact test for four-fold contingency tables.

about one-third of the electroconvulsive personnel. This difference is significant at the .02 level.[6]

In addition to these findings relative to the original hypotheses, certain other qualitative impressions seem noteworthy and relevant to the overall psychological milieu within which these treatments are conducted. Particularly striking was the tendency among both groups of personnel to empathize and identify with the patients undergoing treatment. Such statements as, "If it were me facing that, I would appreciate any encouragement or attention I could get," were frequently heard. In part, some of the more positive feelings toward patients expressed by the personnel seem to represent a reaction against the sadistic, destructive aspects of the treatments. This impression is supported by the finding of a significant inverse relationship ($r = -0.24$) between the ratings of attitudes toward patients; that is to say, a negative view of the treatment is likely to be associated with a positive feeling for the patient.

A further observation suggests the intensity and primitiveness of some of the unconscious fantasies regarding the treatments, particularly electroshock. Several of the interviews, all referring to electroshock, expressed this rather clearly as the following examples illustrate:

> "When I first saw the treatment it reminded me of killing a chicken, wringing the neck and throwing it away. I am afraid of getting shocked myself."
>
> "Holding them down and giving them the treatment, it reminded me of killing hogs, throwing them down in the pen and cutting their throats."

To summarize the principal findings: Both of the original hypotheses are clearly supported. The administration of electroconvulsive treatment often carries with it implications of control or punishment, while no such tendency was apparent for insulin coma treatment. However, motherly, caring attitudes are much more frequently expressed by insulin personnel than by those assisting with electroconvulsive treatment.

DISCUSSION

The above findings point out the difference in the attitudes of auxiliary personnel in the two treatment situations, and emphasize the importance of determining whether these differences have an important impact on the efficacy of the two methods. That a complex interaction exists between the nature of the treatment and the psychological factors operating in the treatment setting is clearly implied. These results, while not casting direct light on the mechanism of action of the shock therapies, do further our understanding of their psychological significance, as well as their effect upon the ward milieu.

The auxiliary personnel, at least in the present sample, seemed to share many of the attitudes described as common among shock therapists. As others have suggested, the mothering, caring aspects of insulin therapy as opposed to the punitive, controlling aspects of electroconvulsive therapy may help explain the differential response of depressed and schizophrenic patients to these two treatments. Insulin coma, offering loving care, seems more effective in schizophrenia, while electro-shock, offering punishment to reduce guilt feelings, is more effective with depression. The bare suggestion in our results of more grossly sadistic, destructive fantasies associated with electro-shock adds some weight to this conception. If such fantasies are prevalent among the personnel, they are likely also to play a role in the patient's unconscious perceptions of the treatment and its significance.

With regard to the greater emphasis on loving care in insulin treatment, it should be noted that in addition to the greater inten-

[6] A reliability check upon this sorting procedure showed that there was only .71 agreement with another judge who was familiar with the purposes of the study but did not know the sources of the interviews. The results of this second judge were not used because of the unknown effects of his knowledge of the study, but it is interesting to note that the results of his sorting were considerably more impressive than those just reported.

sity of mothering responses among insulin personnel, the mechanics of the treatment result in these being exhibited for sustained, long periods of time. Such attitudes might have more difficulty achieving expression without the channel for them provided by the treatment structure. In the settings observed by us, the type of "assembly-line" procedure used for electroconvulsive treatment made the development of close interpersonal relationships with the patients less likely.

Certain problems and limitations of the study should be noted. One author became interested in the attitudes of insulin personnel, and it was six months later that the value of expanding the study to include comparison with electroshock personnel was seen. As a result, a majority of the personnel assisting with electroconvulsive therapy were interviewed by one author and a majority of the insulin personnel were interviewed by another. The potential source of error was recognized; an effort was made to reduce this possible error to a minimum by standardizing the interviews. The limitation of such interview techniques in reaching deeper, perhaps more significant feelings is obvious. In fact, it would be expected that the subjects would be strongly inclined to express only positive feeling and to suppress or deny any negative feelings in order to place themselves in a more favorable light. Finally the degree to which the findings may be generalized might also be questioned since a relatively few treatment settings were studied, and the influence of the particular hospital culture or the physician in charge of the ward may be quite important. There is a considerable need for more controlled studies of personnel attitudes, conscious and unconscious, and their relation to attitudes of the patients and to treatment results.

SUMMARY

This study recognizes the psychodynamic assumption that the total treatment configuration in shock therapies is significant.

Two hypotheses were formulated; that insulin coma treatment would be found to serve as a convenient channel for the expression of loving and caring attitudes, and that personnel would more frequently regard electroconvulsive as a more punitive or controlling type of therapy.

Individual interviews with auxiliary personnel assisting with shock therapies in two state hospitals provided the raw data. Two clinical psychologists independently rated each interview on a scale that denoted positive or negative attitudes toward the treatments and toward the patients who received the treatments.

Both hypotheses are clearly supported and in this sample the auxiliary personnel share many of the attitudes described as common among shock therapists.

Certain limitations of this study are acknowledged. The need for more controlled studies of personnel attitudes and their relation to attitudes of the patients and to treatment results is recognized as a fruitful area for further investigative work.

REFERENCES

1. Abse, D. W. The psychologic implications of shock therapy. Quart. Rev. Psychiat. Neurol., **8:** 287–293, 1953.
2. Abse, D. W. and Ewing, J. S. Transference and countertransference in somatic therapies. J. Nerv. Ment. Dis., **123:** 32–39, 1956.
3. Blek, L. and Navron, L. Somatic therapy as discussed by psychotic patients. J. Abnorm. Soc. Psychol., **50:** 394–400, 1955.
4. Boyer, L. B. Fantasies concerning convulsive therapy. Psychoanal. Rev., **39:** 252–264, 1952.
5. Fisher, S., Fisher, R. and Hilkevitch, A. The conscious and unconscious attitudes of psychotic patients toward electric shock treatment. J. Nerv. Ment. Dis., **118:** 144–151, 1953.
6. Gordon, H. L. Fifty shock therapy theories. Milit. Surgeon, **103:** 397–401, 1948.
7. Hill, D. Psychotherapy and physical methods of treatment in psychiatry. J. Ment. Sci., **100:** 360–374, 1954.
8. Wayne, G. J. Some unconscious determinants in physicians motivating the use of particular treatment methods—with special reference to electroconvulsive treatment. Psychoanal. Rev., **42:** 83–87, 1955.

DISCONTINUANCE OF TRANQUILIZERS AMONG CHRONIC SCHIZOPHRENIC PATIENTS RECEIVING MAINTENANCE DOSAGE

LEON S. DIAMOND, M.D.[1] AND JOHN B. MARKS, PH.D.

INTRODUCTION

Although there has been an abundance of studies on the effects of the administration of tranquilizers there have been few which investigated the effects of their discontinuance. Today, in and out of mental hospitals, many psychiatric patients are on maintenance dosage of tranquilizers. What is likely to happen to them if this dosage is discontinued?

In many cases once a patient leaves the hospital he decreases the tranquilizing medication he is taking or completely stops it. This may be because the hospital has not emphasized to the patient the importance of maintaining himself on drugs or it may be because the person responsible for his outpatient treatment suggests he drop the medication as he becomes able to cope with everyday problems. Are there dangers involved in this ceasing to take drugs? Could it be that for some patients regular daily tranquilizers are as necessary as insulin for the diabetic or digitalis for the cardiac patient?

Unless tranquilizers are necessary for the psychiatric condition there are some disadvantages to their use. First, they are expensive. It has been noted at this hospital that the pre-tranquilizer drug budget was approximately $12,000 per year and now, five years later, the budget has increased to $80,000 per year. For the most part this increase was due to tranquilizers. Is this vast increase in expenditures necessary? Furthermore, with many of the tranquilizers, increased supervision of the patient is necessary to control the development of side effects. Thus, the keeping of patients on maintenance dosage is an administrative problem as well as a therapeutic one.

Good (1) and his group in the Veterans Administration Center, Waco, Texas, conducted a six-month study of the termination of chlorpromazine on schizophrenic patients. They found little change among chronic schizophrenic patients in from ten to twelve weeks when chlorpromazine was removed. They found, however, marked regression and a return to pre-drug symptomatology on patients followed between three and six months. A comparable control group which remained on chlorpromazine showed no such increase in psychopathology. On the other hand Rothstein (2), working with seventeen patients from an open ward at the Veterans Administration Hospital, Togus, Maine, concluded that the withdrawal of chlorpromazine produced no increase in pathology. There was no control group in this investigation.

The purpose of the present study was to evaluate the effects of discontinuance of two phenothiazine derivatives, chlorpromazine (Thorazine) and trifluprom azine (Vesprin) among chronic regressed schizophrenic patients who had been on maintenance dosage of these drugs at least six months. It was also desired to classify patients according to their basic symptomatology and to develop measures other than clinical judgment to evaluate the usefulness of drugs from a prognostic viewpoint.

PROCEDURE

SUBJECTS

Twenty subjects were selected from each of two wards. On one ward the twenty patients had been on chlorpromazine, while on

[1] Veterans Administration Hospital, American Lake, Washington.

the other ward the twenty subjects had been on trifluprom azine. All subjects had been on maintenance dosage for at least six months and none had changed significantly in clinical condition for at least three months. The maintenance dosage of both drugs varied to a moderate degree depending upon the patients' needs. Among the chlorpromazine patients the dosage was from 300 to 800 milligrams per day with an average of 400 milligrams per day. Among the trifluprom azine patients the dosage varied from 50 to 300 milligrams per day with an average of 150 milligrams. All subjects were on only one tranquilizer and none had any organic brain condition. The two ward groups differed initially in their average ages and in their length of hospitalization as well as in the general level of adjustment which they had obtained. Thus the study was designed to make comparisons *within* ward groups and no comparision of the drugs was possible.

Both ward groups were divided into two subgroups. The individual subjects in the subgroups were matched as to their total adjustment as measured by the Hospital Adjustment Scale (HAS) and the subgroups were matched as to average age and average length of hospitalization.

MEASURES

Before the study began, the subjects received an adjustment rating from the ward psychiatrist in addition to the adjustment ratings which were made on the HAS. Each patient was also classified in terms of his predominant symptomatology before tranquilizer medication had been given. This classification was into one of six categories: anxious, depressed, hostile, dependent, thinking disorder, or withdrawn.

The following psychological tests were administered to all subjects: Word Association, Social Memory, Wechsler Memory, Cancelling, Draw-a-Person, and the Rotter Level of Aspiration. A measure of motivation was obtained on all subjects: the number of times which they completed the Digit Symbol subtest of the Wechsler before they were satisfied they had done as well as they could.

TABLE 1

Mean Ages, Lengths of Hospitalization, and HAS Scores for the Two Ward Groups and Their Subgroups

Ward	Subgroup	N	Mean Age	Mean Lgth of Hospitalization (Years)	Mean HAS
Ward 1	Medication (triflupromazine)	10	56.9	16.4	48.7
	Placebo	10	56.2	15.9	49.2
Ward 2	Medication (chlorpromazine)	10	35.7	3.8	76.2
	Placebo	10	36.4	6.8	76.2

WITHDRAWAL OF MEDICATION

In a double blind design, tranquilizers were withdrawn from one of the subgroups on each ward and a placebo of similar appearance was substituted. Patients who were receiving an energizer (Ritalin) along with their maintenance tranquilizer continued to receive it unless there were clinical indications for its discontinuance. At three months and at six months after the beginning of the study the ward psychiatrists divided subjects into three groups (improved; unchanged; and worsened) which represented their clinical course during the study. The HAS ratings also were repeated at the same intervals. At the end of the six-month period the psychological tests were repeated.

Not all patients could be continued on the study for the entire period because of marked worsening in their clinical condition. In the first three months three patients were dropped from the placebo group. In the second three months eight more were dropped from the placebo group and three were dropped from the medication group. Dropouts were caused by such disrupting symptoms as marked hyperactivity, negativism resulting in refusal to eat or get out of bed, decline in physical health, and in some instances the development of marked acting-

out symptoms. In all cases dropped subjects had the study medication (whether drug or placebo) discontinued and they were put on a new medication. For those subjects who were dropped all final measures were taken at the time that they had to be terminated. These final measures included the psychiatrist's rating, the HAS, and the psychological tests.

QUESTIONS FOR INVESTIGATION

The study was designed to answer several questions: 1) In terms of psychiatrist's rating of improvement or worsening of condition, was there any difference between the medication and placebo group? 2) Did this difference hold up in terms of change of HAS scores? 3) Does pre-drug symptomatology predict which patients are likely to be more affected by discontinuance of maintenance tranquilizers? 4) Does performance on brief psychological tests measure HAS adjustment and do these tests predict which patients are likely to be more affected by the discontinuance of maintenance tranquilizers?

RESULTS

1) The medication subgroups from the two wards were combined as were the placebo subgroups. Then medication and placebo patients were compared in terms of the psychiatrists' clinical ratings. There were more of the placebo group who showed a worsening and there were fewer of the placebo group who showed improvement. At the three-month period this difference was significantly only at the .10 level, whereas after six months this was significant at the .01 level.

2) Changes in HAS scores over the three-month and six-month periods were scored for each individual. Since the amount of change depended, in part, upon the initial HAS level, it was necessary to obtain a measure independent of this initial score. This was done by assigning to each individual a score which was the difference in his before and after HAS levels subtracted from that

TABLE 2

Ratings of Improvement for Placebo and Medication Patients at 3 and 6 Months

		(Ward Groups Combined)			
		Improved	Unchanged	Worsened	Total
3 Month	Medication	5	11	4	20
	Placebo	4	5	11	20
	Total	9	16	15	40
	$\chi^2 = 5.624$ $.05 < p < .10$				
6 Month	Medication	8	7	5	20
	Placebo	1	5	14	20
	Total	9	12	19	40
	$\chi^2 = 10.05$ $p < .01$				

which would be empirically predicted on the basis of before and after HAS ratings for the entire group. This change score was computed in such a way that it was higher for those patients who declined in adjustment during the period of the study. Therefore, it can be thought of as a deterioration score. For each ward, individuals on medication were compared with matched individuals on placebos. At the three-month period the placebo group tended to show a higher deterioration score (probability about .10) but at six months there was a clear difference between the medication and placebo groups. The placebo group showed a higher deterioration score ($t = 3.035$) and this difference was significant at the .01 level.

3) The two most numerous classifications of pre-drug symptomatology were those of withdrawal and of thinking disorder. Of the forty subjects, thirteen were in the withdrawal group while sixteen were in the thinking disorder group. Chi-square analysis done separately for the two groups shows that, while in the thinking disorder group there is little difference in the psychiatrist's rating of improvement between the medication and placebo subjects, there is such a difference in the withdrawal group. However, in this small withdrawal group, although the placebo subjects show less improvement than

TABLE 3

Ratings of Improvement At 6 Months for Pre-Drug Withdrawn and Pre-Drug Thinking Disorder Patients

	Improved	Unchanged	Worsened	Total
Withdrawn group				
Medication	2	3	1	6
Placebo	0	2	5	7
Total	2	5	6	13
$\chi^2 = 4.82$				
$.05 < p < .10$				
Thinking disorder				
Medication	3	4	3	10
Placebo	1	3	2	6
Total	4	7	5	16
$\chi^2 = 0.384$				
$p > .80$				

the medication group, the relationship has a probability between .10 and .05.

4) A number of brief tests were found which correlated significantly with initial HAS scores. These include the Word Association, the Wechsler Memory, and the Cancellation test. However, none of these tests correlated so closely that it could be considered an equivalent to the HAS test. None of the changes between the initial and final testings correlated with the deterioration score. None of the initial tests predicted which subjects were likely to respond more favorably during the experimental period.

DISCUSSION

From this study it is concluded that tranquilizer medication is of value in controlling the behavior and symptoms of chronic schizophrenic patients who are receiving only a maintenance dosage of a phenothiazine product. It is noteworthy that the results of discontinuance do not immediately appear in most patients and that many may cease drugs with no deterioration for three months. The fact that a patient can get along for two or three months with a small amount of medication or with none at all may frequently mislead the therapist into thinking that the patient does not need the support that drugs have offered in the past. It should not then come as a surprise when later exacerbation of symptoms develops in such patients. A close followup of these patients would assist in noticing regressive symptoms as they begin to appear so that drugs could be increased and full blown psychotic symptoms averted. This particularly applies to patients who leave a closely supervised hospital program and go to a community where clinical supervision is greatly decreased.

There is some indication that the benefit to be derived from tranquilizing medication varies with the prevailing symptomatology for which the tranquilizer was initially given. For withdrawn patients tranquilizing medication seems more essential than for those patients who are characterized by thinking disorders. It may be that the medication allays anxiety and allows social interaction in the withdrawn group but it does not change the basic pattern of ideation where this is initially disturbed.

Although some brief psychological tests indicate the general level at which a patient is functioning, they are not of value in predicting which patients are likely to benefit from tranquilizing medication.

SUMMARY

Of forty chronic schizophrenic patients on maintenance dosage of one of two phenothiazine tranquilizers, half were put on placebos in a double-blind design. At three months there was a tendency for the placebo group to show deterioration relative to the medication subjects but at six months the superiority of the medication group was definite both in terms of psychiatrists' ratings and in terms of ward behavior ratings.

Brief psychological tests showed significant correlations with the ward behavior ratings. The correlations, however, were not high enough to presume identity of the two measures nor did the tests predict which

patients were likely to react to the discontinuance.

Among patients whose pre-drug symptomatology was characterized by withdrawal, the cessation of tranquilizer seemed to lead to more deterioration than among patients who suffered from pre-drug thinking disorders.

REFERENCES

1. Good, W. W., Sterling, M. and Holtzman, W. A. Termination of chlorpromazine with schizophrenic patients. Trans. 2d Res. Conf. Chemotherapy Psychiat., V. A., **2**: 114–117, 1958.
2. Rothstein, C. An evaluation of the effects of discontinuation of chlorpromazine. New Engl. J. Med., **262**: 67–69, 1960.

SUDDEN REMOVAL OF TRANQUILIZING DRUGS FROM CHRONIC PSYCHIATRIC PATIENTS

GORDON W. OLSON, PH.D.[1] AND DONALD B. PETERSON, M.D.[1]

Too little is known of the effects of ataractic drugs when they are used continuously over a long period of time. This lack of information is of particular concern to those who are involved in the care of hospitalized groups, since patients who do not recover to the point of hospital release often remain on drugs for lengthy periods of time. The decision to prescribe tranquilizing drugs or not to, usually is less difficult than is determination of the point at which the drug has provided maximum therapeutic benefit and at which dosage may be judiciously tapered or discontinued. Many physicians hesitate to discontinue ataractic drugs for fear that if they must be introduced again they may be less effective than initially and because they know that many patients experience difficulty when they cease taking prescribed medication following hospital release. Hesitancy for discontinuing drugs is counterbalanced by awareness that many patients who cease taking drugs following release suffer no ill effects and that negative physical consequences may result from ingestion of tranquilizing drugs by older people (3). The magnitude of the problem is indicated by an unpublished survey by the Minnesota Department of Public Welfare which showed that in June, 1957, one of every three patients in Minnesota state hospitals was receiving such drugs. The proportion may be even greater currently. At least at this hospital, the percentage gradually increased to 42 per cent by June, 1959.

During the course of one of our studies we found that when the drug under investigation was discontinued a majority of the patients remained drug free for at least six months without observable worsening of their condition. This finding led to the speculation that perhaps these and many other chronic patients had been receiving tranquilizing drugs unnecessarily or for an unduly long period of time. Concurrently, support was found in a published report (1) that chloropromazine could be discontinued for a period of three months withot negative effects, although regression occurred when the drug was withheld for longer periods.

These results suggested the feasibility of an intermittent chemotherapy program wherein patients would periodically receive drugs in alternation with drug-free periods. The therapeutic and financial advantages of such a program would be obvious. Before initiating intermittent chemotherapy it was felt necessary to obtain further information about the effects of temporary removal from and re-introduction of drugs. It was toward this purpose that the present study was undertaken, which was designed to provide information on the following questions

1. What percent of chronic patients removed at random from tranquilizing drugs can remain drug-free for specified lengths of time?
2. Do subtle or slowly developing regressive changes in behavior occur when drugs are withdrawn from chronic patients with recognition of regression delayed by the absence of gross or sudden behavioral changes?
3. Are there indications in the behavior of chronic patients receiving ataractic drugs that portend the length of time they will be able to remain drug-free?
4. How effective is the re-introduction of drugs when chemotherapy has been interrupted and regressive behavior has ensued?

[1] Anoka State Hospital, Anoka, Minnesota.

METHOD

From a roster of chronic psychiatric patients at Anoka State Hospital 127 subjects were selected at random. The roster contained the names of all patients in the continued treatment area of the hospital who were receiving ataractic drugs at the time, considered to be under therapeutic control, were not physically ill, and for whom no plans were in process for release from the hospital.

A ward behavior rating was completed by the charge nurse and the drug was immediately discontinued. Ward physicians and nursing personnel were advised that patients could be treated at any time by any method when the usual clinical indications eventuated. If drugs were again indicated a ward rating was obtained the day before administration and again four to six weeks after drug therapy had been resumed. This provided assessments of behavior under the initial drug, without drug at the point of most regressive behavior, and a final measure after the second drug had a reasonable length of time to produce results. When removal was not followed by medication, ratings were obtained eight weeks and six months following termination. The last procedure provided a longitudinal comparison of ward behavior under the drug and no drug conditions.

The ward behavior form used in the study was developed locally and requires no rater training. The schedule covers ten areas of behavior: sociability, disposition, self care, cooperation, mental discomfort, emotional control, interests, activity level, peculiarities and offensiveness of behavior. Each area contains five steps scores, 0 to 4 ,with the higher score always reflecting better behavior. The inter-rater reliability is +.74 and the stability coefficient is +.77. This scale was selected after a comparative study of it and another form (2) revealed comparable reliability and, equally important, the former was preferred by the raters by virtue of its format and language.

RESULTS AND DISCUSSION

Of the 127 subjects who started the study, 117 completed the six months' period. Of the

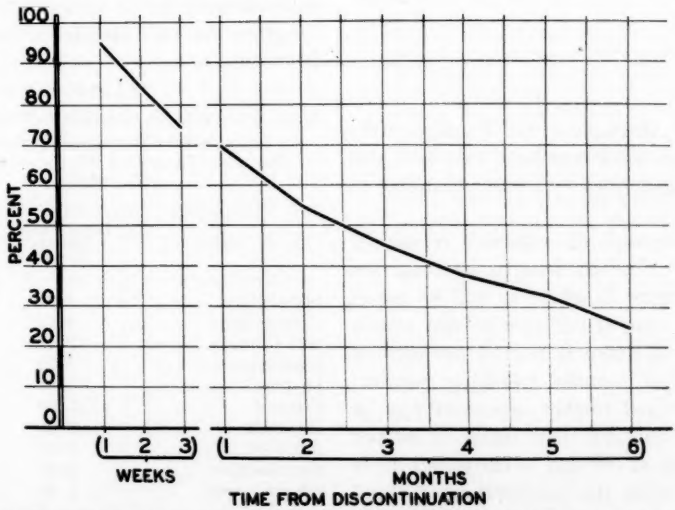

FIG. 1. Percentage of tranquilized chronic, hospitalized, psychotic patients remaining drug and EST free by time from discontinuance of drug up to six months.

TABLE 1

Mean Ward Behavior Ratings Before Drug Removal and Eight Weeks After Drug Removal (N = 51)

Scale	On Drug	Eight Weeks Off Drug
Sociability	1.86	1.73
Disposition	2.96	3.02
Self Care	2.59	2.49
Cooperation	2.94	3.12
Distress	2.67	2.57
Control	3.69	3.73
Interests	1.73	1.57
Activity	2.47	2.43
Peculiarities	2.69	2.65
Offensiveness	3.61	3.73
Total Score	27.20	27.02

TABLE 2

Mean Ward Behavior Ratings Before Drug Removal and Six Months After Drug Removal (N = 27)

Scale	On Drug	Six Months Off Drug
Sociability	2.19	2.07
Disposition	2.96	2.85
Self Care	2.59	2.56
Cooperation	2.96	2.81
Distress	2.67	2.41
Control	2.67	3.81
Interests	1.93	2.07
Activity	2.67	2.74
Peculiarities	2.74	2.56
Offensiveness	3.44	3.44
Total Score	27.93	27.26

ten dropped, three were AWOL, three were transferred to other hospitals, two died, one was discharged, and one was admitted to the infirmary.

The percentage of patients remaining drug-free for various lengths of time are shown in Figure 1, where it will be noted that 70 per cent of subjects at one month following drug removal and 26 per cent of subjects at six months following removal had not received further chemotherapy or electroshock therapy. Our figure of 46 per cent drug-free at the end of three months is at variance with the implication of Good *et al.* that no patients regress for up to three months following withdrawal, although it is noted that the subjects in that study received placebo whereas our subjects received nothing, a difference which we feel is important. In any event, it reveals that the length of the drug-free period that will be tolerated varies considerably with the individual.

The possibility of subtle or gradual deterioration following drug removal was investigated by a comparison of behavior manifested before drug removal with that of two and six months following removal in patients who were drug-free at these intervals. The results of the comparison from the drug to no drug conditions are demonstated in Tables 1 and 2. None of the differences was significant. Thus it is apparent that the patients who were not "retranquilized" did not regress in any manner measurable by the rating scale employed, even up to six months following termination of the drugs.

As to whether any indications are manifest under the drug condition that would predict safe removal from drugs for a short period of time, a comparison was made of ward ratings obtained while still under the drug condition between the 34 patients who required medication within one month of removal and the 53 patients who remained drug-free for two months or longer. Differ-

TABLE 3

Mean Ward Ratings Obtained Before Drug Removal for Patients Who Subsequently Remained Drug-Free Less Than One Month or Longer than Two Months

Scale	Less Than One Month N = 34	More than Two Months N = 53
Sociability	1.97	1.91
Disposition	2.62	2.98
Self Care	2.18	2.58
Cooperation	2.76	2.92
Distress	1.85	2.62*
Control	3.53	3.68
Interests	2.00	1.72
Activity	2.29	2.49
Peculiarities	2.56	2.66
Offensiveness	3.59	3.58
Total Score	25.38	27.16

* $p < 0.01$.

nces between these groups are shown in Table 3, where the only statistically significant difference was that for Distress ($p < .01$). Further study of the scores on the Distress scale indicated that had a score of 2 or less been used as indicating unsuitability for drug removal, 25 of the 34 who remained off the drug for less than 30 days would have been correctly identified as requiring continued chemotherapy, but this would have been at the expense of 35 per cent "misses," since such a score would also have contraindicated the removal of 19 of 53 subjects who remained drug-free for 60 days or more. It is obvious from these findings that observable distress under tranquilization contraindicates drug removal for most patients.

The fourth, and in some respects the most important question, regarding the effectiveness of "retranquilization," was answered by comparison of the rating under the original drug condition with that obtained four to six weeks after drugs were re-introduced. Data were available for 39 subjects. The mean ratings were: under the pre-research drug, 26.38; without drug, 22.67; following four to six weeks of research drug 26.46. The gain of .08 was not significant. This indicates that re-introduction of drugs following removal was as effective as the initial drug, assuming the rating measures effectiveness of action, and we do since the entire clinical picture is compatible with this assumption.

SUMMARY

Psychiatrists and other physicians are often confronted with the dilemma of determining when the patient has received maximum therapeutic benefit from a tranquilizing drug and may be safely removed from medication. Prolonged ingestion of drugs may often be unnecessary and provides physical and economic disadvantages while discontinuation may be followed by periods of emotional turbulance which it is feared will be progressively less influenced by reintroduction of drugs.

This study investigated the effects of sudden interruption of chemotherapy in 127 chronic hospitalized psychiatric patients. The results indicated that 70 per cent of this group could remain drug-free for one month without negative effects, and that reintroduction of chemotherapy, when indicated, was as effective as had been the initial drug. Also, the presence of distress was contraindication to drug removal in the majority of cases, but not all. Finally, the results showed that when personnel found no overt indication for re-introduction of drugs, subtle or gradual deterioration did not occur up to six months following drug removal.

REFERENCES

1. Good, W. W., Sterling, M. and Holtzman, W. Termination of chlorpromazine with schizophrenic patients. Amer. J. Psychiat., 115: 443–448, 1958.
2. Lucero, R. J. and Meyer, B. T. A behavior rating scale suitable for use in mental hospitals. J. Clin. Psychol., 7: 250–254, 1951.
3. Olson, G. W. and Peterson, D. B. The development of intercurrent disease and injury in the tranquilized psychiatric patient. Amer. J. Psychiat., 116: 459–460, 1959.

PSYCHIATRIC MANIFESTATIONS OF ARTANE TOXICITY

Case Report Illustrating the Effect of Trihexyphenidyl on Affective State and Personality Functioning

RICHARD R. BOLIN, M.D.[1]

Among the toxic effects of Artane (Trihexyphenidyl) are psychiatric symptoms which are infrequently emphasized in the lieterature, but which may become severe. They include excitement, confusion, agitation, suicidal mania, delusions and hallucinations (1, 2, 4, 5). In many respects they are symptoms which are reminiscent of toxic reactions to the older belladonna alkaloids. However, in the case to be described, therapeutic as well as toxic doses of Artane produced a particular quality of response which may on further study prove to be fairly specific.

Cases of Artane toxicity which have previously been reported are largely from older age groups. The clinical problem for which Artane was prescribed in almost every case was Parkinsonism, and this was considered in most instances to be symptomatic of underlying arteriosclerotic brain disease (1, 2, 4, 5). In the case to be presented here there is a parallel with reported cases of Artane toxicity, inasmuch as the question of organic brain damage was considered and could not be completely dismissed. What is significant, however. is not whether or not brain damage is present in a given case, but the probability that brain damage, by reducing cortical integrative capacity, predisposes to Artane toxicity, and that the crucial factor has to do with relative or absolute integrative deficit.

The case to be reported here is that of a young woman who developed a toxic psychosis after excessive self-administration of Artane. Her case is unique partly because of the intensity of her drug response, which made it easier to define the psychic effects of the drug. In addition, the effects of Artane could be either traced or observed for a long period of time during which she varied the daily dose of the drug over a wide range. Furthermore, in this case we were given an opportunity to observe the effect of Artane upon personality functioning, when the drug was given specifically for the relief of a symptom which appeared to play an important part in the "economy" of the personality.

CASE REPORT

The patient is a 32-year-old unmarried woman who was admitted to the Psychiatric Division of the University of Illinois Hospitals for treatment of a toxic psychosis due to Artane which had been given to her for relief of a severe torticollis.

Her personality was marked by prominent hysterical features, being characterized by immaturity, emotional lability, and many anxiety-laden masochistic preoccupations. Sexual and aggressive impulses were a great source of conflict for her and were dealt with by the liberal use of repression and by phobic patterns of behavior. She tended to dissipate her energies in organized but restless activity.

A life-long propensity for the development of muscular symptoms was present. She was an active restless person. From time to time she had manifested tics, and slight difficulty with motor coordination, worse when she was under stress, had troubled her since childhood. As an infant she had torticollis due to a birth injury but she had no particular neck trouble during childhood or adulthood until the present illness.

[1] University of Illinois Neuropsychiatric Institute, Chicago 16, Illinois.

The patient's chief personality characteristics—her repressive tendencies which nevertheless were not adequate to prevent feelings of boredom, anxiety and restlessness, and her motility disturbances—are important in the light of later developments. They point to areas of vulnerability in her personality where drug effects as well as the effect of stress most likely would appear, and they further suggest the presence of a substrate out of which conversion symptoms might develop.

Her torticollis began suddenly two years prior to this hospital admission. During a Florida vacation, at a time when she was socially very active, she went wading in the ocean and was knocked over by a wave, whereupon she became terribly afraid that that she was about to die. During the next 24 hours her anxiety diminished but she developed what was diagnosed as "spastic torticollis." This symptom persisted until shortly before this hospitalization, when she became acutely psychotic.

Concurrent with her torticollis she began to suffer with increased anxiety and depression. She found herself unable to adopt her customary lackadaisical attitude. Tension and depression made the torticollis worse. She tried periodically to "get away from it all" by drinking immoderately, or by returning to Arizona to live quietly with her mother for a time.

In 1956 she returned to Chicago, desperately seeking a cure for the torticollis. During her treatment at a hospital outpatient clinic symptomatic treatment was prescribed. Various solanaceous and sedative drugs were used but Artane, she said, "was the only thing that turned my head." Her neck spasm was relieved to a varying extent but her statements indicate that the drug also made her feel somewhat euphoric. This heightened sense of well-being appears to have been a very significant effect of the drug in this case. For nine months she took the prescribed dose of 2.0 mg. four to six times daily. Because she felt so much better she allowed an intense relationship with a married man to develop. Ultimately she felt emotionally over-extended and became increasingly anxious and depressed. She began to drink more than usual and began to take the Artane irregularly but more frequently, whenever she felt "nervous." The dose reached 24–30 mg. or more daily. During a period of one month ideas of reference, vague fears, and increasing irritability and confusion occurred. Ten days before admission she suddenly denounced some of her acquaintances, which was the point at which paranoid delusions crystallized. She feared persecution, murderous retaliation for what she had said, and thought she might be poisoned. She continued to take the Artane indiscriminately, still hoping that it would make her feel better, although at this time the torticollis was not present. Her confusion and agitation finally necessitated hospitalization.

During the acute phase of her illness the patient manifested physical signs of Artane toxicity—dilated pupils, constipation, severe dryness of the mouth, and ataxia. She also had the characteristic signs of a toxic psychosis: a confused, agitated, somewhat disoriented, vulnerable, vigilant state. Sedation and little else but symptomatic treatment resulted in rapid improvement. After two weeks she was free of paranoid symptoms and other signs of toxicity. At one point during the recovery period her torticollis rather abruptly recurred.

In order to test the validity of the diagnosis of Artane toxicity she was placed on an initial dose of 2.0 mg. q.i.d. During a test period of one week she gradually became more irritable and began to verbalize vaguely defined ideas of reference as well as an increased feeling of insecurity, whereupon the trial of medication was stopped. This response to a clinical dose of Artane, which had previously produced no ill effect, is difficult to explain. As in some other cases which we have observed, involving disproportionate drug response, this patient may have over-

reacted to minimal drug effects because of her fear that toxic effects would ensue.

DISCUSSION

With Artane as with many other drugs the therapeutic effects and the toxic effects are related not only to dosage level but also to aspects of personality functioning. This is particularly true of those drugs which alter the affective state of an individual, or which interfere with important adaptive functions such as motility. In the case of Artane the antispasmodic effect on muscles is well known. What are not so well known are the psychic effects of the drug which are emphasized in this paper. When an individual is predisposed by organic or neurotic impairment of adaptive capacity these various effects of Artane may be considerably enhanced with results ranging from heightened affectivity to serious disorganization of thought.

The inter-relatedness of central and peripheral effects of Artane with personality function seems particularly evident in this case perhaps because the personality make-up of the patient made it possible to see effects which, in a better integrated person might not be so distinct. A number of clinical observations which were made during the acute phase of this patient's illness deserve particular emphasis because they dramatize what actually may be common psychic effects of this widely used drug.

During the toxic psychosis the most prominent symptom was a hypersensitivity to stimuli. As a toxic symptom this is certainly not unusual; however, in this instance a longitudinal study of her symptoms and their evaluation suggested that the phenomenon of hypersensitivity to stimuli was actually an exaggeration of a drug effect which had long been present. While acutely ill she was overwhelmed by vivid somatic sensations and by external stimuli, but during many preceding months of Artane treatment the patient already had felt distinctly more responsive, alert and lively, an undeniable state of relative euphoria which could not be correlated with any variable other than the consumption of Artane. Unfortunately, when increased stress led to increased Artane consumption, the pleasant drug-effect became a disturbing toxic symptom. Initially she experienced a disinhibition that was pleasurable; however, when stimuli related to serious personality problems could not be integrated, the Artane excitation led to psychic disorganization.

The explanation of such a clinical effect as this must be somewhat speculative not only because the psychologic effects of Artane need more study and confirmation but also because the neurophysiologic effects of drugs in the Artane group are far from clear (6). Nevertheless, what is known about the neurophysiologic effects of this drug does allow a limited explanation of the clinical phenomena.

By virtue of some special affinity Artane is thought to reduce neural activity in the basal ganglia. There are two results which relate to the clinical symptoms which have been described. In the first place higher centers of the brain are "released" so that there is a disinhibition of cortical functions. In addition there is an element of sympathetic nervous system excitation which probably affects the higher centers. Secondly, the tonal feedback in the lower internuncial pools is reduced (3, 6). The reduction in peripheral muscle tension which results may be responsible for a reduction in some somatic determinants of anxiety. Central and peripheral effects of Artane may in this way produce the euphoria which has been described.

Another noticeable characteristic of the clinical picture in this case is the fact that paranoid trends were an outstanding feature. This is a finding which is in agreement with other writers who almost invariably have mentioned that paranoid trends were part of severe Artane toxicity (1, 2, 4, 5). The finding of marked paranoid features can be brought into accord with important features

of this patient's personality and with the finding, which has been discussed, that Artane causes a hypersensitivity to stimuli at the cortical level. What had initially been for this patient a pleasurable state of alertness and euphoria eventually became simply a state of overstimulation. She felt increasingly vulnerable in the face of sexual and aggressive feelings which had always been poorly integrated, so that when stress and Artane consumption increased she ultimately lapsed into an excited, fearful, paranoid state.

A third point of clinical interest in this case concerns the symptom of torticollis which followed a clinical course complementary to the psychotic symptoms. This supports the general impression that monosymptomatic neuroses are quite likely to mask a paranoid state. It can be argued, on the other hand, that the relationship between the psychotic symptoms and the torticollis is a temporal one reflecting changes in overall CNS function; however, there is evidence in this instance that interference with motor-muscular function deprived the patient of a customary avenue for the disposition of tension and for the expression of conflict solutions. When the muscle spasm yielded completely, acute paranoid symptoms ensued and during the course of recovery the abrupt return of torticollis was the point at which paranoid trends became less distinct. The implication is that when the customary adaptive function was interfered with by the effects of Artane, more primitive adaptive and defensive responses became manifest.

SUMMARY

A case of Artane (Trihexyphenidyl) toxicity in a 32-year-old woman is presented with emphasis upon the psychiatric findings and their determinants. In addition to well known antispasmodic effects Artane causes psychic responses of a potentially serious nature, particularly in those predisposed by organic deficit or neurotic incapacity to problems of adaptation or integration.

In the case presented Artane induced a state of euphoria, an increased sense of well being, which counteracted depressive feelings. This may be a chief effect of the drug. In this case it led to indiscriminate self-administration; this in turn eventuated in the psychiatric syndrome which may be characteristic of Artane toxicity: a paranoid state with varying degrees of excitability and/or euphoria.

Artane produces a heightened sensitivity to stimuli which may be the neurophysiologic substrate out of which psychic disorganization and paranoid misinterpretation arise.

Artane was given for relief of a torticollis which had the appearance of a conversion symptom. The relief of this symptom was correlated with psychotic disorganization.

REFERENCES

1. Canelis, M., Farnell, F. J. and McGavack, T. H. Clinical experience witha new type of antispasmodic ("Artane"). Amer. J. Med. Sci., **218**: 655–659, 1949.
2. Corbin, K. B. Trihexyphenidyl: Evaluation of a new agent in treatment of Parkinsonism. J.A.M.A., **141**: 377–382, 1949.
3. Doshay, L., Zivarelli, J. and Loewy, P. Recent trends in the treatment of Parkinsonism. Med. Record., **160**: 339, 1947.
4. May, C. R. Parkinsonism. In *Notes and Comments*. Brit. Med. J., **1**: 202, 1950.
5. Porteous, H. B. and Ross, D. N. Mental symptoms in Parkinsonism following benzhexol hydrochloride therapy. Brit. Med. J., **2**: 138–140, 1956.
6. Salter, W. T. *A Textbook of Pharmacology*. Saunders, Philadelphia, 1952.

ROLE OF EMOTION IN THE PRECIPITATION AND EXACERBATION OF SYMPTOMS AND IN THE UNEXPLAINED DEATH OF AN ADOLESCENT WITH DERMATOMYOSITIS: A CASE REPORT

JACK RAHER, M.D.[1] AND ANGELES M. FLORES, M.D.[1]

With the current intense focus on the physiological impact of emotional stress, observers have shown increasing interest in the psychological settings in which a wide range of clinical entities develop (14), in the more specific correlations between mood and exacerbations of symptoms (4) and in the occasional instance in which death occurs without obvious explanation (18). This is a report of some evidence from the case of an adolescent with the clinical pathological diagnosis of dermatomyositis with associated Raynaud's phenomena.

CASE REPORT

Norma N. was a seventeen year old white female, admitted to the psychosomatic ward on July 8, 1959 with the diagnosis of Raynaud's Disease. Somatic manifestations present on admission were thickening and fissuring of skin over the hands and some swelling and tenderness in the right forefinger. She was a short, well-developed, attractive redhead who appeared intelligent, well oriented, with intellectual functions intact, and though somewhat tense, no thought or mood disturbance was evident. There was no previous history of emotional or somatic difficulties prior to the winter of 1958. There appears to be such an obvious correlation between the stress provoked by family interaction and appearance of symptomatology, that a brief description of the former is indicated here.

Norma was the second of five children. The father was a chronic alcoholic who had not supported the family for several years and who was verbally and physically abusive to the patient and to the rest of the family. In addition to this openly sadistic behavior toward his family, there was almost continuous drinking and flagrant involvement with other women. The patient was particularly infuriated when the father parked in front of the house while entertaining the opposite sex. In spite of the grossly pathological behavior, the mother had always permitted the father to return to the family, while suggesting to the patient that he not be condemned for his actions. The mother was physically like the patient and managed to care for the family and run the business which supported them. While the patient spoke of the father with obvious anger and disgust, she emphasized how much she felt the children owed the mother, the respect due her, and in mild terms, disappointment that the mother could accept the father in spite of his brutal behavior.

In the winter of 1958, the patient began to have frequent headaches. She attributed this to the fact that her father's drunkenness and abusiveness had become more frequent, giving her "no time to forget." In March of 1959, the father was charged with abusiveness and drunkenness. The charges were not pressed, and the mother permitted him to return to the family. Shortly after this event, Norma began suffering from nausea, vomiting, anorexia and pain over the eyes. She stayed home from school and remained in bed. During this time, in the course of another drinking spree, the father again assaulted the family. The patient's symptoms persisted; she was hospitalized, and a diagnosis of sinusitis was made. After a twelve-day hospitalization, she was weak, but improved and returned to school. In the meantime, the patient's mother charged the

[1] The Psychiatric Institute, University of Maryland School of Medicine, Baltimore, Maryland.

husband again, but this time the police insisted that another member of the family request the warrant since, on previous occasions, the mother had never pressed the charges. The father threatened to kill any child of his who would testify against him. The patient was willing to "sacrifice" herself to protect the rest of the family and volunteered to testify against him. When the patient took the stand she saw her father's face, was frightened, but testified against him. She states that "everything came to a head then." She became "cold all over" and dizzy. As soon as she was out of the courtroom she fainted.

A week after the trial, the patient noticed that her hands were blue and fingertips very cold. Gradually, the hand began to appear purplish. This was particularly true of the fingers which she described as "bruised-like, cold, and very tender." The local physician diagnosed this as Buerger's Disease and prescribed pills which proved ineffective in relieving the symptoms. Although the original dosage was doubled, the symptoms progressed. The skin of the fingers became thick and fissured. Her arms felt heavy and ached. Hospitalization was then advised. During this time, the father had been given a five-year sentence which was suspended on condition that he stay away from home. The patient believed that the father would disregard the court order and was extremely fearful that he would reappear. In May, 1959, the patient was admitted to the University Hospital medical service. The only abnormalities found were confined to the fingers. The terminal phalanges were cold, tender, and somewhat hyperemic in some areas and blanched in others. The skin over the fingers was thickened and fissured. She was placed on Arlidin and was seen regularly by a psychiatrist. On May 27, a right stellate ganglion block was done with relief of symptoms on the right side. Progressive objective improvement was noted. On the 33rd hospital day, she was discharged with diagnosis of Raynaud's Disease, condition improved. She was receiving 50 mgm. of Priscoline three times daily and was scheduled to see the psychiatrist on a weekly basis. A week after her discharge, she began to have deep muscular aches in both thighs and was then admitted to the psychosomatic ward.

PERSONALITY STRUCTURE AND DYNAMICS

The evidence from psychological tests indicated that Norma was a constricted passive-dependent person, one of whose primary conflict areas was dependence on the mother and intense ambivalence regarding such dependence. While there was intense identification with the mother, the patient perceived her as a controlling, dominating and sadistic person. Nevertheless, the mother was seen as the only reliable figure and Norma showed no conscious awareness of the intense negative feelings engendered by her. It was suggested that the ambivalence toward the mother was so strong that inability to express feelings in this area was responsible for the production of some of her somatic complaints and for the blocking of perception. The male figure was seen as "hot headed," and capable of "killing without realizing what they are doing." There was an awareness of the frightening aggressive threat from the father and of her own murderous feelings toward him. Associated with the above was openly expressed hostility toward the older sister, who enjoyed a particularly strong relationship with the father.

WARD BEHAVIOR AND SOMATIZATION

The relationships Norma established on the ward mirrored the picture outlined above. In a setting containing both sexes and a population with a wide age range, she established consistent relations only with the older, less aggressive women. There was a marked compulsive element in her behavior. She was exceedingly polite and correct in her behavior and extremely neat in appearance and in the care of her personal things. She resented any show of aggression, or untidiness on the part of the other adolescents.

Shortly after her arrival, a variety of transient somatic complaints became manifest, and these are presented in summary form below.

Second hospital week: During the second week of hospitalization and on the day following psychological testing, she complained of generalized itching. The itching had started during the first part of the test when she was asked to interpret what she saw in the Rorschach cards. As the examination proceeded, she felt increasingly irritated with the examiner and the itching became worse. With the second part of the test, she felt more at ease and the itching disappeared. Toward the end of the test period she began to associate the tests with her troubles at home and to experience a headache. The headache disappeared when she was in the recreation room and "forgot all about the morning's tests." Later in the evening, she began to think about the different psychological procedures and the generalized itching returned. Upon awakening the following morning, she noted a rash on her arms, forearms, thighs, legs, and around her waist. During the course of the next two days, the skin rash diminished and the itching gradually disappeared.

Two days later, she was visited by the mother and her older sister and went shopping with them. She learned at this time that her mother had left the patient's little sister at the same home in which the father was staying. She interpreted this as an obvious gesture toward rapprochement and could not understand why the mother and sister did not feel as she did toward the father. After learning about this, she had a "funny" feeling inside, followed by generalized itching. The following day, she complained of sore throat, difficulty in swallowing, chest pain, and tenderness on her right second and third fingers.

Third hospital week: The day the patient expected her mother to visit, she appeared depressed and complained of stomach ache and anorexia. She talked about her mother's coming later in the day with no apparent affect. However, at the time she expected her mother to arrive, Norma went shopping with the O. T. worker. Her mother was delayed because she had to go to her doctor because of chest pains. When the patient later related this, she was smiling and appeared very much amused. The day after her mother's visit, the patient stayed in bed because of abdominal pain (which she attributed to menstruation). The following days, she appeared cheerful and free of somatic complaint.

Fourth hospital week: After deciding to return home for a weekend, the patient became notably depressed. In the interviews that followed, she reverted to talking about her father's abusiveness and cried a great deal. She did not complain of itching nor of other somatic complaints. Her skin looked better, being less red and having fewer eruptions. At this time the skin of her hands and fingers was noticeably softer, smoother, and there was no tenderness.

When the patient returned from the weekend at home, there was numbness and tenderness in both hands. The skin over the fingers was again thick with some fissuring present. During the two days at home she had felt "awful" and "tired" all the time. There had been a few episodes of fainting. She never felt safe, was tense and stated that she felt safer now that she was far away from the father. Two days after returning to the hospital, the tenderness in the fingers disappeared.

There was intermittent appearance of the somatic complaints during the ensuing three weeks. They appeared to be related to reactions to the other patients as well as to the contacts with home and family problems. These were transient and although Norma appeared hostile and isolated from the other patients, her functioning in terms of hospital activities was at a very high level.

Eighth hospital week: During the eighth week, she expressed the desire to return to school. It should be noted that the patient

had, prior to her illness, functioned exceptionally well at school. She had made excellent grades, was a leader in extra-curricular activities, and had formed fairly intense relationships with her teachers. One of these she habitually addressed as "Mom" and discussed with her the difficulties at home. She was aware that her intense activity at school had been helpful in limiting the preoccupation with her conflicts at home. When it was definitely decided that she was to be discharged and seen as an out-patient, she became markedly depressed and more withdrawn from the other patients. She began to complain of weakness and aching in the muscles of her arms and thighs. During her last four days, she iterated how much she had enjoyed her stay and her sadness at leaving. Two days before discharge, she was very depressed and cried throughout the day. She continued to complain of dizziness and weakness. She was assured that she could return to the hospital if things did not go well. This seemed to reassure her somewhat and she began to feel better.

INTERIM NOTE

When the patient returned home, she learned that the father had made a single attempt to obtain money from the family, and when threatened with legal action, had not contacted the family again. He was presumed to be living with some woman in a nearby town. The patient became progressively weaker and continued to have deep muscle pains. She was so weak and stiff that she was unable to get in and out of the school bus unaided. The principal suggested that she stay home until she felt better. She began to have difficulty in swallowing, her skin rash recurred, and she began to lose weight. Ten days after discharge, she returned to the dermatological clinic for a check-up and because of her poor general appearance was referred to the medical service. She remained on the medical service during the ensuing two weeks. There she underwent further intense testing and was seen by her psychiatric therapist on the medical ward. During this period, the patient's complaints persisted. These featured myalgia, skin eruptions, weakness and anorexia associated with a weight loss of twenty pounds. She had difficulty in swallowing and spoke in an unnatural, high-pitched voice. Norma appeared severely depressed in mood and voiced disappointment at not being readmitted to the psychosomatic ward. The evening before she died, she attended a musical program given by patients and seemed to enjoy the performance. Later that night, she made a curious request of the duty nurse, asking for permission to pray. Approximately one hour later (2 a.m.), she was found dead while still leaning across the bed in an attitude of prayer.

DISCUSSION

Engel (6), in an article entitled "A unified concept of health and disease," has emphasized the need for an examination, in all disease entities, of the continuous interplay of the various constitutional and experiential factors. The reports in the literature on dermatomyositis (with or without associated Raynaud's phenomena) are practically devoid of information pertaining to the setting in which the disease develops or that which explores the relationship between emotional factors and the exacerbation of symptoms. In the case here presented there appears to be an extremely suggestive correlation between the emotional impact of increasingly intense social pathology upon an adolescent and the appearance of somatic complaints culminating in her death. Aside from this non-specific effect, there are several aspects of this case worth noting.

The first stems from the observation that the somatic responses appeared to vary according to the mood or affect associated with different stressful situations. For example, following the patient's "sacrifice" in testifying against her father, she literally feared that her father would kill her. It was shortly after this episode that symptoms characteris-

tic of Raynaud's phenomena became manifest. Psychological tests supported the idea that there existed, on both conscious and unconscious levels, an awareness of the extremely frightening aggressive threat from the father and of her own murderous feelings toward him. Clinical material tends to corroborate the idea that the predominant affects involved were anger and fear. The appearance of this symptomatology in such a situation is in keeping with reports in the literature which suggest that: Raynaud's Disease often follows a major emotional trauma (10) and which emphasize the significance of death as an experience, an idea or threat and of sexual fears and guilt in the production of symptoms (9). Of special interest in this regard is the work of Graham (7) who found a differential physiological response while measuring skin temperature under conditions of hostility, anxiety and depression.

In contrast, the most striking somatic response occurred in relation to transactions with the mother. The early contacts with the mother were marked by exacerbations of symptomatology which could be seen as early stages of the more serious manifestations which were present (following a prolonged stay at home) during the last few weeks of life. Both the clinical observations and data obtained from psychological tests pointed to the critical importance of the mother-child relationship. We thought it probable that the patient felt her role in the banishment of the father as an act of hostility toward the mother and that this served to alienate the latter and to make somewhat more manifest the patient's intense latent hostility. Thus the deterioration of this relationship, abetted by separation from the family and by the secondary effects tending to accentuate her sense of isolation, *i.e.*, "rejection" at school and, to some degree, in the hospital—all acted to promote the mood of depression and despair and the concomitant physiological effects which apparently played a role in the appearance of her organic illness and in her dying.

Such an interpretation is consistent with the concepts of various investigators who have emphasized the significance of the mother-child symbiosis in "psychosomatic" disorders. Benedek (2) regards the depressive constellation as the inherent psychobiological response to any disturbance of the emotional symbiosis between mother and child. Engel (4) mentions several studies which demonstrate "the extraordinary consistency with which interruptions of object relations seems to act as the precipitating circumstance for a variety of major somatic changes." This same author, in considering alternative symptoms and associated affect in his study on ulcerative colitis patients (5), suggests that a particular psychobiologic situation might be a prerequisite for a specific somatic complaint. In comparing headache and bowel symptoms, he indicates that the different affective states associated with these symptoms might be a clue to the prerequisite psychobiologic situation. Finally, Will (18) describes adolescence as a critical period in the development of the individual's capacity to relate and suggests that, "the failure to develop the needed relatedness in infancy leads to marasmic death. The loss of relatedness later in life leads to panic, a sense of the loss of self, and in some instances to death."

The preceding statement serves to introduce a final point of interest: the relatively abrupt and somewhat puzzling character of the patient's death. Although, clinically speaking, she appeared to be seriously ill and was felt to be suffering from an entity (dermatomyositis) which most frequently proves fatal, neither the clinical evidence nor the subsequent autopsy studies (brain was not included) could give a convincing explanation of her abrupt demise. This brings to mind similar cases of unexplained death which are reported from widely disparate sources, *i.e.*, anthropology (3), psychiatry

(1, 13, 15, 16, 18, 19), internal medicine (8, 17) and experimental psychology (12). We are aware of the important differences that exist in the cases discussed by these investigators but feel that there are common elements which emerge from a consideration of their findings which might be applicable to the case presented here.

In general investigators in this field have sought answers to the following questions. Can one accept the idea that intense emotion can provoke death? It seems a reasonable certainty in view of the many cases described and the careful pre and post mortem examinations made. What is the qualitative and quantitative character of emotion capable of inducing death? If one examines the cases cited in the references above, the emotions named are usually fear, anxiety, rage and grief. Certainly these emotions do not normally produce death so that the character of these emotions must have a special quality in cases which end fatally. Various authors cited above emphasize the following. 1) Its intensity: best expressed by Rosen's collection of terms "highest degree of anxiety," "driving anxiety," "demoniacal fear." This is seconded by Cannon's "terror" and Mira's "malignant anxiety." 2) Primal quality: by this we refer to the symbolic content as suggested by Rosen's "This fear is an enormous one, because, as the productions reveal the patient anticipates murder at the hands of an infantile love object." Again, the situations in which the above factors obtain are not synonymous with death. What then might be the special circumstance which seems a necessary condition for death to ensue? An extremely suggestive note is struck by the more or less consistent appearance of such ideas as "social isolation," "the conviction that the individual had that he was doomed" (Cannon); "the immense difficulty of reaching the severely regressed individual behind his catatonic defense" (Rosen); "One could envisage disease and depression as attempts at adaptation to feelings of helplessness and hopelessness" (Schmale); and finally, "The move toward intimacy involves increasing anxiety; the failure to make the move brings loneliness and the threat of unrelatedness. The extreme of either course is panic and the feeling of impending, if not actual, dissolution and death" (Will). In short, a sense of isolation, of unrelatedness, of impending doom, of hopelessness and helplessness. What are the possible physiological explanations for production of death in these cases? The explanations available (with the possible exception of those attributed to Cannon and Richter) are not experimentally validated but, although based largely on autopsy findings, remain speculative. Perhaps it would be useful to divide some of the more current explanations offered into the following groups: 1) Normal-exhaustive (Cannon, Mira); prolonged sympathetico-adrenal response leading to circulatory failure. 2) Normal-nonexhaustive (Richter, Laurence); brief overactivity of parasympathetic system with vagal arrest of the heart or with ventricular fibrillation (Stephan). 3) Psychotic-exhaustive with generalized somatic response (Shulack); generalized toxemia (products exhausted musculature), deranged glucose metabolism, with peripheral dilation of the small vessels (sustained parasympathetic response), lowered blood pressure, circulatory failure. 4) Psychotic-exhaustive, without hyperpyrexia or cerebral engorgement (Shulack); excess carotid sinus cardiac standstill along with central reflex vagal cardiac standstill.

Finally the question of antidote is posed. Here there is striking unanimity of opinion. In cases in which there is generalized somatic reaction, important emphasis must be placed on techniques designed to ensure adequate intake of food and water and maintenance of chemical balance (1, 15). However, as Adland and Rosen suggest, this is not adequate to ensure survival of the patient. The vital factor for these authors and others is the

utilization of techniques with the patient which permit the latter to believe that some solution to the emotional conflict is possible and that living is therefore a tenable proposition. They indicate that, in view of the intensity of the emotion involved and the terrible isolation, casual techniques are of little avail and nothing short of intense psychotherapy could be effective.

REFERENCES

1. Adland, M. L. Review, case studies, therapy, and interpretation of the acute exhaustive psychoses. Psychiat. Quart., **21:** 38–67, 1947.
2. Benedek, T. The psychosomatic implications of the primary unit: Mother-child. Amer. J. Orthopsychiat., **19:** 642–654, 1949.
3. Cannon, W. B. "Voodoo" death. Psychosom. Med., **19:** 182–190, 1957.
4. Engel, G. L. Selection of clinical material in psychosomatic medicine. Psychosom. Med., **16:** 368–373, 1954.
5. Engel, G. L. Studies of ulcerative colitis. III. The nature of the psychologic processes. Amer. J. Med., **19:** 231–256, 1955.
6. Engel, G. L. A unified concept of health and disease. I. R. E. Trans. Med. Electronics, Vol. ME-7, Jan., 1960.
7. Graham, D. T. Cutaneous vascular reaction in Raynaud's disease and in states of hostility, anxiety, and depression. Psychosom. Med., **17:** 200–207, 1955.
8. Laurence, J. Z. A case of sudden death without any adequate post-mortem experience. Brit. Med. J., **1:** 376, 1860 (as reviewed in Adland, Ref. 1).
9. Millet, J. A. P. Psychoanalytic psychotherapy in Raynaud's disease. Psychosom. Med., **18:** 492–505, 1956.
10. Millet, J. A. P., Lief, H. and Mittelmann, B. Raynaud's disease: Psychogenic factors and psychotherapy. Psychosom. Med., **15:** 61–65, 1953.
11. Mira, E. Psychiatric experience in the Spanish war. Brit. Med. J., **1:** 1217–1220, 1939.
12. Richter, C. P. On the phenomenon of sudden death in animals and man. Psychosom. Med., **19:** 191–198, 1946.
13. Rosen, J. N. A method of resolving acute catatonic excitement. Psychiat. Quart., **20:** 183–199, 1946.
14. Schmale, A. H. Relationship of separation and depression to disease. I. A report on a hospitalized medical population. Psychosom. Med., **20:** 259–277, 1958.
15. Shulack, N. R. Sudden "exhaustive" death in excited patients. Psychiat. Quart., **18:** 3–11, 1944.
16. Stephen, H. Natural death as a result of great excitement in acute psychoses without demonstrable cause. Z. Ges. Neurol. Psychiat., **152:** 480, 1935 (as reviewed in Adland, Ref. 1).
17. Weyrich, G. Erfahrungen über den plötzlichen Tod aus innerer Ursache bei Kindern un Jugendlichen. Deutsch. Z. Ges. Gerichtl. Med., **22:** 116–149, 1933 (as reviewed in Adland, Ref. 1).
18. Will, O. A., Jr. Human relatedness and the schizophrenic reaction. Psychiatry, **22:** 205–223, 1959.
19. Yawger, N. S. Emotions as the cause of rapid and sudden death. Arch. Neruol. Psychiat., **36:** 875, 1936 (as reviewed in Adland, Ref. 1).

MILLER, DANIEL R. AND SWANSON, GUY E. *The Changing American Parent: A Study in the Detroit Area.* Wiley and Sons, New York, 1959. xiv + 302 pp. $6.50

This book describes the reported child-rearing practices of the parents of about 600 children in the Detroit area. It is based on a study made under the auspices of the Detroit Area Study, an annual sample survey of the Detroit Metropolitan area. Each year those responsible for the Detroit Area Study make a portion of their facilities available for scientific research. The authors of the present book, an interdisciplinary team of proven productivity, used the opportunity so provided them to test empirically some of their ideas about American child-rearing practices.

On the basis of their study of historical sources (recommended practices in mass media over the past hundred years, memoirs and letters of articulate spokesmen of their times over the same period) the authors have shown a trend in preferred patterns of child-rearing and in the rationales associated with these preferences. The older-fashioned methods tended to stress internalization, self-denial and the capacity for delaying gratification (*e.g.* with scheduled feedings, early and stringent weaning and toilet training, and pressures to be independent relatively early); the newer methods tend to stress capacity to adjust to others and a greater interdependence on others for setting personal norms (*e.g.* with self-demand feeding, later and more permissive practices around transitions in feeding, toilet and independence training).

Earlier social psychological studies, particularly those psychoanalytically oriented (*e.g.* Kardiner and Linton) tended to stress the primacy of child-rearing practices in affecting modal personality and cultural institutions. The present study is significant in its attempt to go further by delineating factors that affect child-rearing practices in a particular society. The authors stress the importance of historical forces—particularly ideological and economic—in affecting such behavioral patterns as child-rearing practices. The child-rearing practices are seen, in effect, as intervening variables between historical forces on the one hand, and the modal personality of the society on the other. In the Post-Reformation Era, the entrepreneurial ideology and the economic forces of an expanding economy created a cultural ethos within which child-rearing practices stressing independence and delayed gratification seemed to people of that time to be most appropriate. As the socio-economic system has changed—with the secularization of society, the growth of large corporate enterprises and elements of the welfare state—a different set of child-rearing practices and rationales for them have become current. The authors imply that the choice of practices and rationales for them have been more determined by the forces chronologically behind the parents than by a rational gearing-in of practices to the future requirements of a changing society.

Given the idea that our society is changing and that its complexity leads to uneven change, some parts of society (*i.e.* those more tied to the entrepreneurial mode of making a livelihood—or as the authors term it, those in an "entrepreneurial integration") are more likely to use, and feel as right and proper, the old-fashioned modes of child-rearing. They feel that such a correlation would validate the use of the entrepreneurial-bureaucratic variable in explaining the diversity of child-rearing practices in contemporary society. Classification of "integration setting" as entrepreneurial was made on the basis of the breadwinner's occupation (*i.e.* deriving from commissions, fees or profits) or on the basis of the deriva-

tion of at least one of the parental families from farms (where the entrepreneurial orientation was presumed to have prevailed) or from foreign countries (where a similar lag was presumed to have been in force). Conversely, the classification of bureaucratic integration setting was used when none of the above conditions prevailed and when the breadwinner was engaged as a salaried worker in a complex organization (*i.e.* with at least three levels of supervision).

Many elements of the findings reported lend some support to the authors' hypothesis of a correlation between old-fashioned modes of child-rearing and entrepreneurial integration. But with the exception of the pattern seen in the lower middle class, the support appears tenuous. The relationship is small in the upper middle class, and almost nonexistent in the lower class groups. From one point of view, the findings are discouraging; from another, rather heartening. The authors had hoped to establish their concept of integration settings as a factor of pervasive significance—over-riding social class, education, religion, neighborhood and the like—as a determining element of the diverse contemporary child-rearing practices. However, given the welter of social types, the plethora of child-rearing practices and the scope of the line of thinking to which the admittedly superficial research instruments were applied, the fulfillment of even this limited aspect of the hypothesis is noteworthy. Furthermore, the study is valuable in the degree to which it explicates the various factors that might explain the current diversity of child-rearing practices. Many factors other than the one of integration setting were examined in the sample—factors that had been supported in other studies or in the writings of novelists. On the whole, these other factors fared even less well as determinants of the various patterns of child-rearing.

One is left wondering whether the limited validation of the central hypothesis indicates that the idea is basically sound (the shortcomings of the empirical findings being due to the admittedly poor indices of intimate, complex retrospective material drawn from direct-approach brief-exposure surveys); or whether the hypothesis is valid only for a portion of the American middle classes, different hypotheses being called for to explain the patterning to be found in other subgroups of the population. Clearly both factors are relevant, but it would seem that the latter conclusion will probably be more productive in future research.

The present work is valuable not only for sorting out factors involved in understanding the diversity of child-rearing practices and tying its own line of thought into the writings of such people as Freud, Riesman, Davis and Havighurst, but in terms of some possible "applied" implications. For clinicians there is an interesting section on the implications for family life and the development of neurosis with the bureaucratic trend. An appreciation of the relativity of child-rearing practices in various family contexts might be another contribution to clinicians, who are becoming increasingly aware of the importance of diverse sub-cultural contexts to which their patients are oriented. For parents generally, the authors feel that their study contributes a perspective that may allow them to see their own child-rearing practices in less absolute terms; social forces and not natural laws affect parental tendencies to favor one or another child-rearing practice. An understanding of this may facilitate a flexibility in rearing children which will contribute to their eventual emotional development and interpersonal competence.

Rhona Rapoport

LEWIN, BERTRAM D. *Dreams and the Uses of Regression*. International Universities Press, New York, 1958. 64 pp. $2.00

This is one of the Anniversary Lectures established in 1951 to celebrate the birthday of Sigmund Freud, which have been given annually since that time by the New York Psychoanalytic Institute. In this lecture Dr.

Lewin continues his contribution to the study of dreams, his main area of interest for many years. He has contributed important papers on such subjects as dream screens, blank dreams, the psychoanalytic process in sleep and the relationship of the phobic facade to dreams. In the present paper Dr. Lewin investigates the dream structure in relation to certain philosophic and scientific concepts which were developed by Descartes.

As Dr. Lewin points out, Heraclitus clarified the fact that dreams were a personal, individual experience and not a part of external reality, and thus separated the dream world from the external, experiential world which could be a matter of common observation and experience. In 1952 Dr. W. R. Ashby stated that in the physical sciences we go farther and exclude all inner experience, so that consciousness is merely the observing organ of perception. Thus the basic metaphysical principles applied to the scientific view of the world would imply a non-participating observer and an objective world; or, in the terms originally used by Descartes, "a res cogitans," and the "res extensa," (the thing that has extension in time and space.) This leaves man in the position of a mere spectator, taking no part in the objective world.

In this monograph Dr. Lewin states, "I shall try to show that Descartes' realistic view of the world is the view that we commonly find in an ordinary, well-projected visual dream when the dreamer is the pure and irrelevant spectator." He goes on to discuss dreams of a different nature during which the body may be actually felt and experienced in the dream and points out that in such dreams sleep is superficial and that disturbances of sleep usually occur. In those dreams in which stimuli from the body are successfully excluded sleep is best preserved. Inasmuch as most dreams are visual and more or less completely projected they appear as objective and external and completely outside of the observer.

Descartes reported that on November 10, 1619, he had three dreams which were unusual in nature: he was convinced that they were revelations from God and spoke of them as marking a decisive point in his career. He said that they brought him the complete conviction that mathematics was the sole key needed to unlock the secrets of nature. The first two dreams were characterized by the fact that they included many body sensations and he was in no way just the observer. Thus he experienced a weakness in his right side, an "impetuous wind which whirled him around," and a feeling that he was falling at every step, and he noticed that the other people around him stood straight on their feet and were not affected by the wind. After awakening from the first dream he prayed to God for protection and health, but after an interval of two hours again fell asleep and had a second dream replete with body sensations in which there were sharp, piercing noises and an optical experience of fiery sparks. Again he fell asleep and had a third dream which was entirely different from the earlier ones. In this dream there were no unusual body sensations and the context of the dream was very close to conscious fantasy. This latter dream he went on to interpret as a revelation from the Angel of Truth who had descended from heaven to reveal to him the treasures and truth of all the sciences. Descartes felt that the first two dreams were admonitions from God. He interpreted his terror as related to remorse and the peal of thunder as a sign that the Angel of Truth had entered into him. When Freud was asked to comment about this series of dreams he suggested that this type of dream expresses abstract or symbolic ideas; therefore such dreams need not be interpreted by the analyst but that the dreamer could translate it immediately inasmuch as the ideas are near to conscious thoughts. This does not mean that there may not also be deeper interpretations as well.

Dr. Lewin then makes the assumption that Descartes's dreams took place during a

period of ill health that embodied either migrainous or convulsive symptoms. The evidence for this includes the fact that Descartes had had intimations of such a dream for several days; the strange sensory and motor images that appeared in the dream, such as the unilateral paralysis, spinning on the left foot, the feeling of staggering and sensations of a high wind, and finally, the experience of sparkling lights with a loud thunder clap which continued into the waking state and which had been experienced previously, are all cited as strongly suggestive evidence. In the first two dreams it seemed impossible to get rid of the disturbing somatic experience Descartes was undergoing; it appeared directly in the dream as his own body experience and could not be objectified into the external world, and thus his sleep was disturbed. By the time he fell asleep and had his third dream he was no longer subject to the physical illness or attack and the dream material was completely objectified, so that his body was a mere unfeeling part of the projected dream picture. We know that Descartes interpreted this last dream in a symbolic way and felt that it was crucial for his later development. Dr. Lewin points out other examples of dreams in which original ideas or artistic discoveries have seemingly appeared for the first time.

In view of the importance of this series of dreams to Descartes it is probable that they occupied his attention to a great degree and were worked over repeatedly, both on conscious and unconscious levels. Whether he was aware of it or not, one of the main problems was how to exclude body sensations in the dreams so that he could have only mental ego feelings, remain a detached spectator and preserve sleep. Dr. Lewin brings forth the probability that within the ten years that elapsed between the dreams and the writing of his famous "Discourse on Method," Descartes came upon the solution. Lewin hypothesizes that when Descartes came to formulate his scientific picture of the world he made it conform with the state of affairs in an ordinary successful dream. Thus the dream, which had been excluded from scientific exploration, came back to provide a model for the philosophic point of view called dualism. The author speculates further as to what effect dreams that are not of the ordinary visual type may have had in the shaping of other non-Cartesian philosophic concepts of mind and matter, such as those of Einstein, Leibnitz and Lao-Tse.

A. Russell Anderson

Hanraets, P. R. M. J. *The Degenerative Back and Its Differential Diagnosis.* D. Van Nostrand Company, Princeton, 1959. x + 690 pp., illus. $19.95

This volume, divided into three sections, presents a most complete discourse on the painful low back.

In the first part the author, a neurosurgeon, discusses his motivations for the compilation of data assembled. In the first two chapters he proposes that a degenerative constitution exists in some cases which accounts for unsatisfactory relief of symptoms by simple surgery of the intervertebral disc.

In the second section he extensively surveys the literature from the structural, constitutional and dynamic aspects of the low back. Chapter Three is most thought-provoking, and constitutes a valuable reference source to the theories of the structural etiology of low back weakness.

In the third part, the author presents an analysis of his own material. Chapter Six, on symptomatology and differential diagnosis, is to this reviewer a most stimulating contribution. Chapter Seven, on the degenerative back as part of the degenerative individual, evaluates the author's thesis in light of his personal experiences. In the final chapter, he discusses therapy of all types.

While some conclusions and approaches to the problems of diagnosis and therapy of the painful low back are contrary to the general consensus in this country, this scholarly

analysis merits respect and profound consideration in the world literature of the painful low back.

R. K. Thompson

WASSELL, B. BOHDAN. *Group Psychoanalysis.* Philosophical Library, New York, 1959. 306 pp. $3.75

In several ways this book is something of a paradox. While it is primarily written for the experienced group-therapist, many of its views, implications and conclusions will seem artificial and shallow in the light of our present knowledge of psychopathology. The term psychoanalysis, as used by the author, would make one seriously question whether it is not here a misnomer. A statement such as, "the Oedipus complex, for example, a construct based on Frazer's primitive horde observation may today apply only fragmentarily to modern man. Where there is a surplus of females, there will be little necessity for the son to eliminate his father . . ." would make one think the author has discarded this concept entirely, but he immediately reintroduces it with an important alteration: ". . . the growing male child in our culture and many others senses the lack of soft growth in himself and so seeks to align himself with these attitudes through union with his mother and hostility toward his father who personifies hardness." This confusing explanation is an obvious attempt to desexualize the idea of early sexuality, which accounts much more clearly, directly and fully for observed clinical phenomena. The well-known concept of Horney, which describes interpersonal dynamics as moving toward, away from or against people is used to a considerable degree by the author. At times the use of this concept seems to imply an unwarranted dichotomy between the way people relate to each other and their intrapsychic factors. As most clinicians know, many schizoid patients remain remote and aloof out of hostility to and out of fear of their excessive dependence on others.

Group Psychoanalysis is presented as an extensive review of the author's therapeutic ideas, illustrated by many clinical vignettes in which the patients are usually described by their main characterological traits or attitudes, *e.g.*, "resigned, expansive-aggressive, self-effacing etc." Many of the observations and recommendations seem sound enough in regard to these attitudes. The fact that prominent character traits are often used defensively to cover and conceal precisely their opposite, so that much of the therapeutic work consists in helping the patients become aware of this other side of their personality is clearly shown again and again in the book. This kind of emphasis will appear excessive to many readers, as it tends to overlook or ignore the personological complexities of the individuals described.

The book's presentation would have been strengthened considerably both through better organization of the material and more careful editing. The excessive use of "etc.", "predominately" (sic) and "group" or "individual" as short-cut terms for "group analysis" or "individual analysis" are especially noticeable.

The conclusions of the author, who recommends the combined use of individual and group therapy in many cases, may be well-founded; but clearer and more objective validation than may be found in this book is certainly needed.

Albert E. Dreyfus

LEVITT, MORTON. *Freud and Dewey on the Nature of Man.* Philosophical Library, New York, 1960. 180 pp. $3.75

The author has selected a very interesting, but most challenging topic: to compare the achievements of two leaders in the field of psychology; Freud, born in 1856 in Austria, and Dewey, in 1859 in U. S. A. Both had a revolutionizing influence on their contemporaries in an era in which science gained supremacy over religion. Both accepted no statement on the strength of higher authority. Dewey attacked traditional philosophy, Freud opposed descriptive psychiatry. They

both elicited great adoration and angry protest among their contemporaries, but neither paid much serious attention to the other's work. The author mentions that both were the offspring of marriages in which the father was about 20 years older than the mother. But besides mentioning some rather superficial similarities, Levitt does not contrast the great differences of social environment in which both leaders were raised, nor the influence of the professional occupation. Dewey was a teacher and educator, and Freud a physician, to start with. The author develops at some length the intellectual ancestry of the two men.

Dewey's pragmatic instrumentalism and experimentalism was determined by the methods of modern science and he was indefatigable in criticism of ancient classical philosophy. He chose Kant for his doctoral dissertation and found in Hegel the ideas of synthesis to overcome the disintegrative individualism of modern times. Calvin S. Hall and G. S. Morris were his teachers. The influence of Comte and later of Darwin has been pointed out. An exchange of letters between William James and Dewey that showed first appreciation of the older psychologist degenerated later into an acrimonious debate. The concepts of George H. Mead remained unassimilably obscure to Dewey.

Freud, while auditing the lectures of Brentano, the teacher of intentionalism, in Vienna, translated John Stuart Mill's works into German. He was influenced by Darwin, Galton, Fechner, T. H. Huxley, and Helmholtz, whose disciple, Brücke, was his teacher in the neurophysiologic laboratory. Freud dismissed philosophical influences, spoke with great reverence of Goethe and Plato, but he built up his own philosophy and replaced Herbart's mechanistic psychology of associations by a new psychology of his own, influenced by Charcot and aided by Joseph Breuer. The hypnotist Bernheim is not mentioned by the author as an influence on Freud.

The author sketches Freud's system, his theory of instincts, the division of the psychic apparatus into an unconscious, preconscious, and conscious part, the theory of dream interpretation and the technique of therapy.

The system of Dewey is much less completely formulated. While Freud put the emphasis on the individual and his longitudinal development, Dewey was more preoccupied with the adjustment of the individual to his environment. One of his most influential early essays is "The Reflex Arc Concept in Psychology." He maintained the tripartite division of the mind into knowledge, feeling, and will. Interest represented the emotional side of consciousness. The activity of the self, either in raising or lowering the level of its activity, expressed itself in feeling. Feeling specified itself into likes and dislikes, loves and hates. Hate was felt as hindering the realization of the self. Normal feelings were regarded as real values, and degenerate forms of feeling appeared as self-consciousness. Emotional dispositions under the control of will formed habits and constituted character. Dewey's theory of conflict was similar to that of Freud; so was his concept of transference of emotions. The understanding of habits became the key to social psychology, the operation of impulse and intelligence the key to individualized mental activity. Dewey maintained the conception of will. What Freud called instinct seems to Dewey an artificial simplification. He spoke of impulse and desire. Intelligence converted desire into plans. Dewey gave up an inner and private self for the larger social self.

Levitt quotes a doctoral thesis of Dr. McCormak (p. 153) who explains Dewey's disinterest in psychoanalysis as a therapeutic method on the grounds that Dewey, in a personal crisis due to his unpopularity during World War I, received a kind of physiotherapy which stimulated in him new ideas on habit and voluntary action in contradistinction from psychoanalysis. Levitt makes an effort to reconcile Freud's and Dewey's

ideas and explains their differences as of a romantic nature. But Dewey was dissatisfied with Freud's concept of instinct, his systemic reification of concepts like unconscious, ego, id, superego. It seems to this reviewer that the author deemphasizes the differences implied in the more tragic attitude of Freud in his evaluation of the conflicts arising between the individual, his instinctual needs and the demands of the cultural environment. Dewey, on the other hand, was less skeptical about the possibility of adjustment in human society and aimed with disarming optimism towards the reconciliation of the individual and his society.

Edith Weigert

NORRIS, VERA. *Mental Illness in London.* Chapman and Hall, Ltd., London, 1959. 317 pp. 35 s.

This monograph describes the patient population admitted to two psychiatric observation wards and three mental hospitals in the London area between 1947 and 1949. The records of approximately 11,000 patients were summarized and coded; information was then added from a follow-up period which lasted until the end of 1951. The subjects of the survey therefore were under scrutiny for periods varying from 24 to 59 months.

The observation wards involved were the largest in London, containing 82 and 76 beds respectively; the three mental hospitals each housed 2200 to 2300 patients. These facilities served some 1,600,000 persons resident in Southeast, South and North London. The completed survey thus yields a wealth of information regarding the broad pattern of mental illness as it presented in 1947–1949 in a large Western city.

In her monograph, Dr. Norris succinctly outlines the statistical methods used in the survey, reviewing briefly relevant work by earlier authors. She employed a probability level of .02 to indicate significance, compromising between the conventional levels of .01 and .05. Age and sex specific first admission rates to each mental hospital, and the three hospitals together, were calculated to the base of one million people in the hospital catchment areas: these amounted to 700 per million men and 900 per million women. Dr. Norris discusses these rates in detail, noting that they are below the (1951) levels for England and Wales (790 per million men and 990 per million women). The expectation of mental disorder was calculated, as also discharge and death rates; hospital life tables were compiled, and 12 cohorts of patients were analyzed, whose follow-up ranged from two to five years (patients followed up for less than two years were calculated on the total sample). The survey data suggest that, in 1951, the probability of admission to mental hospital at some time in life was 5.8 per cent for men, 7.2 per cent for women, and 6.5 per cent for persons generally. When the mortality of hospital patients was comcompared with that of residents in Greater London it was considerably higher.

Successive chapters of the monograph describe the age, sex and diagnostic distribution of persons admitted to Observation Wards in the County of London, and the Outcome of Treatment in Observation Wards, together with aspects of the hospital care of the following groups: 1) mentally ill persons in London, 2) patients with schizophrenia, 3) patients with manic depressive psychosis, 4) patients with mental disorders of old age and 5) patients with other psychiatric disorders.

In studying the vast amount of carefully compiled data presented in Dr. Norris' book, the reviewer cannot but admire the industry and painstaking care with which the material has been sifted, collated and interpreted. There are many tables relating the characteristics of mental illnesses to sex, age, and marital status; and the work is rich in information concerning the prognosis of mental disorders at the time of the survey. Administrative and economic considerations receive attention; the urgent need for continued psychiatric research is underlined by the

heavy price the individual and the community pay for mental illness.

For the average American reader, the concept of the observation ward may be somewhat involved but will be of interest in its legal provisions and therapeutic expedience. One advantage of this arrangement receives no mention. As one who has worked in a London observation ward—not one of those studied in Dr. Norris' book—this reviewer would remark the training value of such units for the beginning psychiatrist, particularly with respect to his exposure to a kaleidoscopic variety of clinical syndromes. In these wards, and in this monograph, the values and virtues of diagnosis—a neglected exercise in some centers—are underlined and reaffirmed. Concordance in diagnosis between observation ward and mental hospital lends support to the belief that accurate diagnosis is necessary, feasible and irreplaceable for purpose of contemporary research. The importance of "nosocomial influences"—the availability of mental hospital accommodation, and variation in psychiatric diagnosis—is emphasized in the monograph; Dr. Norris found them to be of such potency that she was not able to relate mental disorder to socio-economic class. All her conclusions are statistically validated; they are cautious, but, supported by the evidence she has marshalled, extremely impressive.

One salient point that emerges from Dr. Norris' work is the adverse prognosis of mental illness during the time of the survey (1947—1951), optimistic opinions of clinicians to the contrary. At the time the survey was carried out, mental hospital admissions were steadily rising: since 1956, however, a reversal of this trend, presumably related to the widespread introduction of neuroleptics, has made itself evident. In the light of this changed situation, it is fascinating to reflect what a survey for the years 1959–1960 would show. When such a survey is attempted, its author will be able to base many, if not most, of his conclusions on Dr. Norris' lucid, impressive and comprehensive work.

Anthony Hordern

DE ROPP, ROBERT S. *Drugs and the Mind*. Grove Press (Evergreen Books), New York, 1960. x + 310 pp., paperbound. $1.95

The author of this monograph was formerly associated with the Rockefeller Institute as a biochemist. The volume consists of an introduction, written by Nathan S. Kline, and nine chapters variously entitled: Mind and Matter; The Mind and Mescaline; The Mind and Marihuana; Addicts and Addiction; Chemistry of Madness; Sick Minds, New Medicines; Brews Strange and Brews Familiar; and The Shape of the Future. In addition there is an appendix, bibliography and index.

This is essentially a book for the layman. It presents, in a well written, easily read, often humorous and informative manner, a deal of interesting, factual information about drugs concerning which a great deal of romanticism has developed, such as mescaline, marihuana, opium, alcohol, etc., and some of the newer psychopharmaceuticals whose place in psychiatric treatment is still uncertain.

The chapters on mescaline and marihuana are well worth perusing. Here the author has drawn heavily on the literary formulations of Aldous Huxley, Weir Mitchell, Havelock Ellis, Baudelaire, Ludlow (*The Hasheesh Eaters*) as they have portrayed their subjective experiences with these compounds. Perhaps more might have been added to the presentation of these drugs if the author could have been a little more speculative as he observed the highly sophisticated scientist and the primitive jungle man seeking to bring about an effect on his cerebration which would transcend the limitations of his daily world. What are the forces which confront man with the temptation to know more about the drugs "whose past and sometimes present is the basis of a cult, a religion or a way of life?"

The chapter on addicts and addiction deals mainly with opium and its derivatives, heroin and morphine, and alcohol. A few remarks are made relative to the barbitu-

rates and benzedrine. The information presented helps to clear up many popular misconceptions about these drugs. The section dealing with the chemistry of madness makes comparisons with mescaline intoxication and then goes on to reemphasize the possibility of a schizophrenia resulting from a "metabolic error" by giving a Paul de Kruif-like treatment of the development of the adrenochrome, LSD, and Serotonin theories as possible structural models. Unfortunately their limitations are not discussed, leaving the reader with a kind of vague awareness that chemistry must be involved in some way. The chapter is finally completed by a brief account of such psychiatric treatments as electroconvulsive therapy, insulin coma and prefrontal lobotomy. What the author is attempting to imply by these latter associations is uncertain to this reviewer.

"Sick Minds, New Medicines" is a brief historical presentation of the new drugs which have been introduced in psychiatric treatment in recent years. These are reserpine, chlorpromazine azacyclonal (Frenquil), meprobamate, "Meratran," methyl-phenidylacitate (Ritalin), the combination of Pentothal and Methamphetamine administered intravenously and the use of LSD as an adjunct to psychotherapy. Unfortunately, except for reserpine and chlorpromazine, very little information is presented relating to the other drugs except to convey the impression that they are effective. No consideration as to their possible limitations is given.

"Brews Strange and Brews Familar" is in essence a kind of thumbnail or abbreviated enumeration of the history and usage of such compounds as tea, coffee, and cocoa, alternating with such unfamiliar ones as caapi, or ololinquin, kola, guarana, kava, teonanacatal, cohaba, betel, muchamor, kat and tobacco. The material presented is a good point of departure for those who wish to seek additional information.

As to the future, the author concludes that we are already in the situation described by Aldous Huxley in his futuristic fantasy, *Brave New World:* "Wheels must turn steadily, but cannot turn untended. They must have men to tend them, men as steady as the wheels upon their axles, sane men, obedient men, stable in contentment." It was to obtain this stability that the brave new world developed "soma," a drug which combined the properties of an ataraxic with those of a euphoriant and hallucinogen. If mankind must take an occasional holiday from reality, it is certainly high time the chemists found a more satisfactory "happiness drug" than that dreary old nerve poison, ethyl alcohol.

Albert A. Kurland

PASAMANICK, BENJAMIN, ED. *Epidemiology of Mental Disorder*. American Association for the Advancement of Science, Washington, D. C., (Publication No. 60), 1959. x + 295 pp., illus. $6.50 (Prepaid to AAAS members: $5.75)

The study of the distribution of a disease in the population with a view toward identifying groups at elevated risk, and the determination of the unique characteristics of such groups is basically the method of epidemiology. Studies of this type generally require the cooperative endeavor of many investigators. In order that the separate contributions can be used to establish hypotheses of worth, a common understanding of the disease under investigation must be presumed.

In recognition of Emil Kraepelin's work in the late nineteenth century, particularly in the construction of a logical classification of mental diseases, a symposium on the "Epidemiology of Mental Disorder" was organized by the American Psychiatric Association to commemorate the centennial of his birth. The topic of the symposium was indeed appropriate, for without a nosological framework for the mental disorders, epidemiology could hardly be used with benefit to probe for causes in the jungle of entities which are encompassed by the term, mental disorders. From the papers presented at the symposium and included in the publication

under review, one is impressed with the need to improve the classification of mental disorder now used, if the epidemiological method is to prove more worthwhile.

There would appear to be no single stated objective for this book. The prospective type of investigation is the basic method underlying papers describing such diverse relations as nervous illness and outcome of pregnancy, housing environment and mental health, and serves also as the basis for developmental studies of intellectual potential in infants and of personality change in the second decade of life. The methods for accomplishing the essential yet extraordinary task of estimating the prevalence of mental disease in a community are the subject of two symposium contributions. Also noteworthy are studies in the class of demography dealing with the distribution of schizophrenia in a small city and with seasonal variations in hospital admissions for senile psychosis.

The experienced epidemiologist will be interested in noting the difficult path which is the lot of the mental hygientist in applying standard epidemiological methods. The mental hygientist accustomed to intensive study of small clinic experiences will find this set of papers concerned with community studies a worthwhile investment of time.

Matthew Tayback